A dissertation submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfillment of the Degree of Doctor of Philosophy

Defects of Multinational Emission Trade Systems

Post-Kyoto Recommendations Based on the Analysis of Fraudulent Practices and Regional Fuel Price Differences in Multinational Emission Trade Regimes

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Budapest

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ABSTRACT OF DISSERTATION submitted by:
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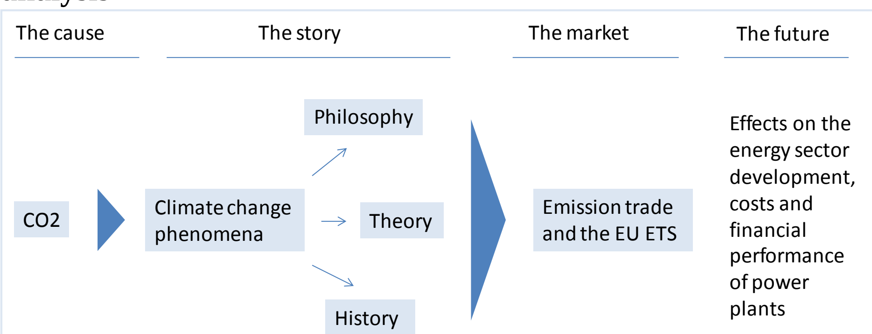
Abstract

Climate change is one of the most influential concepts of the environmental agenda that induced on the one hand successful multinational environmental cooperation and on the other hand became one of the most debated spheres of environmental sciences and economy development policies.
The dissertation is to describe how a one molecule non-hazardous element became the alpha and omega of sustainable development in the end of the 20th century. The dissertation provides a description of climate change phenomenon its background, history and establishes the grounds for future policy actions. The study also describes the role of the economy in framing the CO_2 agenda and the relevant economy theories that make the emission trade inevitable for achieving sustainable development in the 21st century. A detailed assessment of the performance of the EU Emission Trading Scheme identifies the main deficiencies of multinational emission trade, namely fraudulent activities and regional fuel price differences. The analysis of fraud in emission trade targets to derive usable methods for preventing criminal or unfair practices in any future emission trade system. An analysis of regional fuel price differences and the potentials of the Green Investment Schemes (GIS) as a tool to complement emission trade mechanisms is to base policy advice by providing usable methods for future emission trade systems post- Kyoto.
The study endeavors to fill in the gap of scientific research in the field of climate change by evaluating the economy theories, emission trade systems, the green investment scheme and the two main deficiencies of emission trade systems: the ability in addressing fraudulent activities and the phenomenon of regional fuel price differences.
Based on these efforts recommendations to post-Kyoto cooperation are to be presented which are able to enhance the effectiveness of any operating emission trade systems, help overcome their defects and ease the acceptance of future multinational emission trade as an economy tool to curb anthropogenic greenhouse gas emissions.

Logic of the analysis



Keywords: *climate change, sustainable development, emission trade, energy industry, post-Kyoto, economy theories, green investment scheme, climate fraud, regional fuel prices*

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAU – Assigned Amount Unit
BAT – Best Available Technology
CAPEX – Capital Expenditures
CC – Compliance Committee
CDM – Clean Development Mechanism
CEE – Central and Eastern Europe
CER – Certified Emission Reduction
CEU – Central European University
COP – Conference of Parties
CO2 – Carbon-dioxide
EC – European Commission
EIT – Economies in Transition
ERU – Emission Reduction Unit
EU – European Union
EUA – European Union Emission Allowance
EU ETS – European Union Emission Trading Scheme
GHG – Greenhouse gas
GIS – Green Investment Scheme
GJ – Giga joule
HFC - Hydrofluorocarbon
IEA – International Energy Agency
IET – International Emission Trading
IPCC – Intergovernmental Panel on Climate Change
IT – Information technology
JI – Joint Implementation
KPI - Key performance indicator
LC – Linking Capacity
LDC – Least developed countries
LNG – Liquefied natural gas
MC – Marginal cost
Mt – Million ton
MTF – Missing Trader Fraud
MWh – Megawatt hour
NAP – National Allocation Plan
NGO – Nongovernmental Organization
N2O – Nitrous oxide
OPEX – Operating Expenditures
O&M – Operation and Maintenance
OTC – Over the Counter
TCM – Trillion cubic meter
TJ – Terra joule
UN – United Nations
UNEP – United Nations Environmental Programme
UNFCCC – United Nations Framework Convention on Climate Change
VAT – Value Added Tax
WMO – World Meteorology Organization

1 INTRODUCTION

Present days, climate change has become the main concern of the environmental protection agenda. It has been a long journey through science, media and policy which enabled the phenomenon to be formed, debated, agreed on and debated again and by the 21st century to become the focal point of the international environmental cooperation and the sustainable development agenda. Meanwhile it remained one of the most debates spheres of sustainability study undeniably it has gained the widest international agreement ever achieved in the international environmental agenda, through the signature of the Kyoto Protocol.

The idea of changing climate has evolved a long time ago meanwhile most think it is a new one. In reality, it roots back to the end of the 18th and the beginning of the 19th century and since that has gained growing interest both public and scientific. Unquestionably, the media had a major role in the evolution of the phenomenon through framing the idea of global warming, climate catastrophes, and science fiction like dystopias. The media has also amplified the public debate which has indisputably an irreversible effect on the concept. Scientific knowledge has gone through a considerable evolution and although has reached a fundamental agreement on the effects of greenhouse gas emissions of human activities and the resulting possibility of climate change it remained a widely debated sphere of science. It is a disputed one because the human experience on meteorology and climate is remaining, so to say, short thus direct comparisons are not available. Climate change is a complex phenomenon having a series of potential reasons, side effects, and a list of feed-back mechanisms that is why the scientific assessments hardly can bring undeniable results and will have always a lower probability. Simple to say we never know if mother Earth has a special last minute solution for the rising carbon dioxide levels of the atmosphere to be absorbed through natural processes. Heavily debated if human emissions impact severely the atmosphere and also which contribution it may have in reality to natural geological, meteorology or climate conditions of the Earth. Thus skeptics may always say that until sound evidence is to be presented there is no need for immediate action. Counterargument could be, also widely used, that when we humans will all experience the proven effects of climate change it will be too late to conceive action to combat it.

Our society is built upon the need for growth. If growth cannot be realized then an economic crisis or a war renews the setup of the society and economy. As the climate change issue and greenhouse gas emissions are closely related to economic development, such a tool is required to combat it which enables both at the same time the expansion of the economy and the mitigation of climate change. Emission trade provides a sound market-based tool to implement climate conscious policies in the present economy system. A market based tool of intervention that enables the market wisdom to reach cost effective greenhouse gas emission reductions based on the classic rules of macro economy. Emission trade is a new economy tool to address the problems of greenhouse gas emissions and thus there are topics which have not been investigated yet and consequently has deficiencies which end up in illogical solutions, operational and regulatory defects and open the sphere for actions which are independent from environmental protection, target purely the generation of business profit or even let unfair or fraudulent approaches prevail.

Greenhouse gas (GHG) emission of industries and the society inherently affect the globe with causing a rise of the CO2 level in the Earth's atmosphere. Because of its global effects the actions that are directing at GHG emission reduction shall be most effective when global measures are taken and global cooperation is achieved.

The main aim of the dissertation is to provide solutions to overcome the deficiencies of multinational emission trade system and to help enhancing the economy tools applicable to curbing global greenhouse gas emissions serving the ultimate goal of the least cost approach in environmental conscious economy development. For the purpose of achieving the aim of the research several objectives have been defined: identify the experienced defects of emission trade systems; typology development; investigate the background to each defects; establish the framework for the assessment of regional fuel price differences in multinational emission trade context; analyze the achievements of the Hungarian Green Investment Scheme; describe the potentials of Green Investment Scheme as a tool to enhance future multinational climate protection activities; provide policy advice and regulatory recommendations to overcome each of the defects of multinational emission trade and frame the recommendations to structure applicable policy advice.

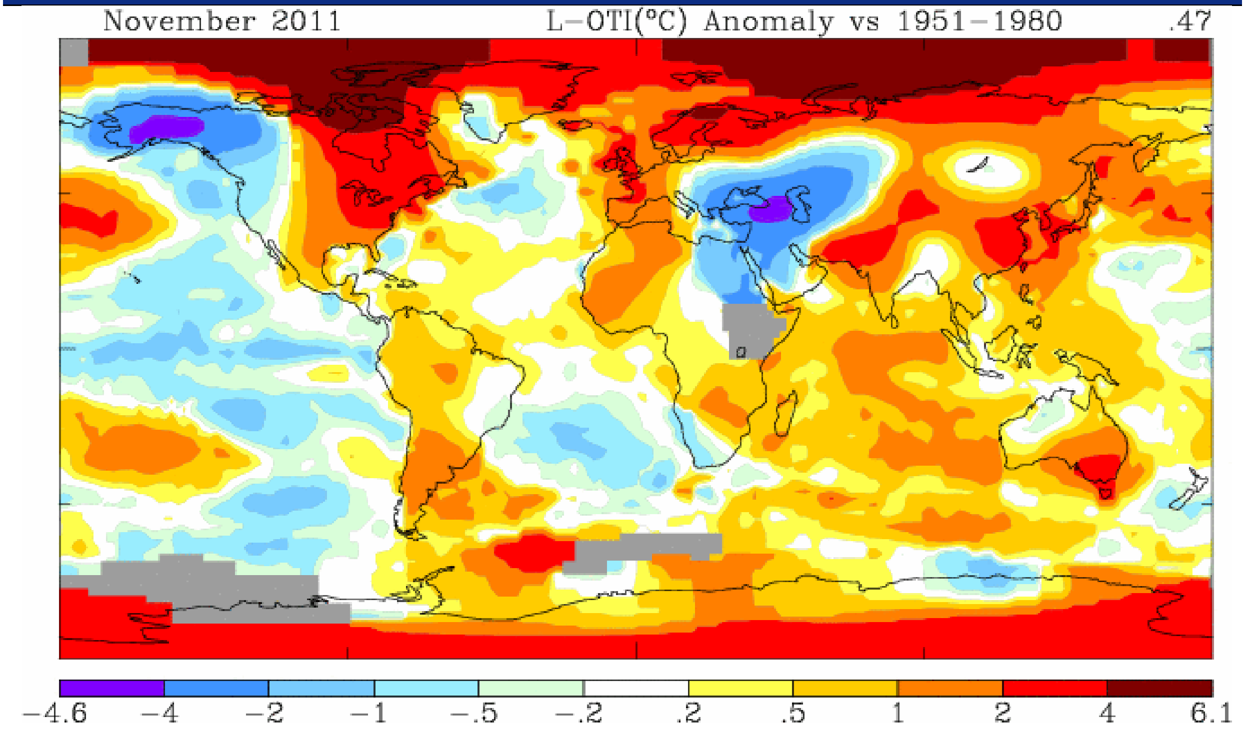
2 THEORETICAL BACKGROUND

Carbon dioxide (CO_2) was always present in the Earth's atmosphere and had its role in influencing the climate which is also confirmed by assessments executed on the Earth's ice cores. Identifying the physics of the atmospheric carbon dioxide and the detailed description of this process took about 200 hundred years and is still going on. Nevertheless, the scientific knowledge of atmospheric mechanisms and the ability in modeling and forecasting future deviations of climate patterns became more and more sophisticated and thus there are already enough evidences available to conclude that carbon dioxide has a major role in forming the meteorology and climate conditions of the globe.

Present carbon dioxide levels expressed in percentages are minor based on the chemistry of the air, more than 98 % of the atmosphere is made up of two elements Nitrogen: 78,084% (N_2) and Oxygen: 20,947% and the remaining 1-2% consists of other gases such as inert or trace gases, including CO_2 (Argon (Ar) 0,934%, Carbon Dioxide: 0,0314%, Neon (Ne): 0,001818%, Methane (CH_4): 0,0002%, Helium (He): 0,000524%, Krypton (Kr): 0,000114%, Hydrogen (H_2): 0,00005%, Xenon (Xe): 0,0000087%, Ozone (O_3): 0,000007%, Nitrogen Dioxide (NO_2): 0.000002%, Iodine (I_2): 0,000001%, Carbon Monoxide (CO): trace, Ammonia (NH_3): trace (composition of air in percent by volume, at sea level at 15°C) (**Lide et al., 1997**). Obviously, the amount of CO_2 is small compared to other gases nevertheless its effect is much greater than its share would directly imply.

The climate change concept has been initially named as global warming but it has been questioned by stakeholders as based on world temperature measurements not the whole globe warms up but certain parts warm faster than others and some are cooling down, that is why global warming has been rejected and the concept of climate change proposed to the scientific and policy agenda.

Figure 1: Global temperature anomalies



Source: NASA

The debate around climate change was there since the inception of the concept and became even fiercer in the last decades. Climate models although have deficiencies have gone and are going through a software renaissance and thanks to the hardware development of information technology more and more accurate results are to be drawn up. Based on the findings of scientific models and analyses and the resulting policy development one of the most widely used international cooperation has been established namely the United Nations Framework Convention on Climate Change (UNFCCC) that ignited a new sphere of environmental conscious economy development path that is the climate or emission trade market. The climate market has more dimensions from which some affect companies, some countries and another ones regions or the multinational level.

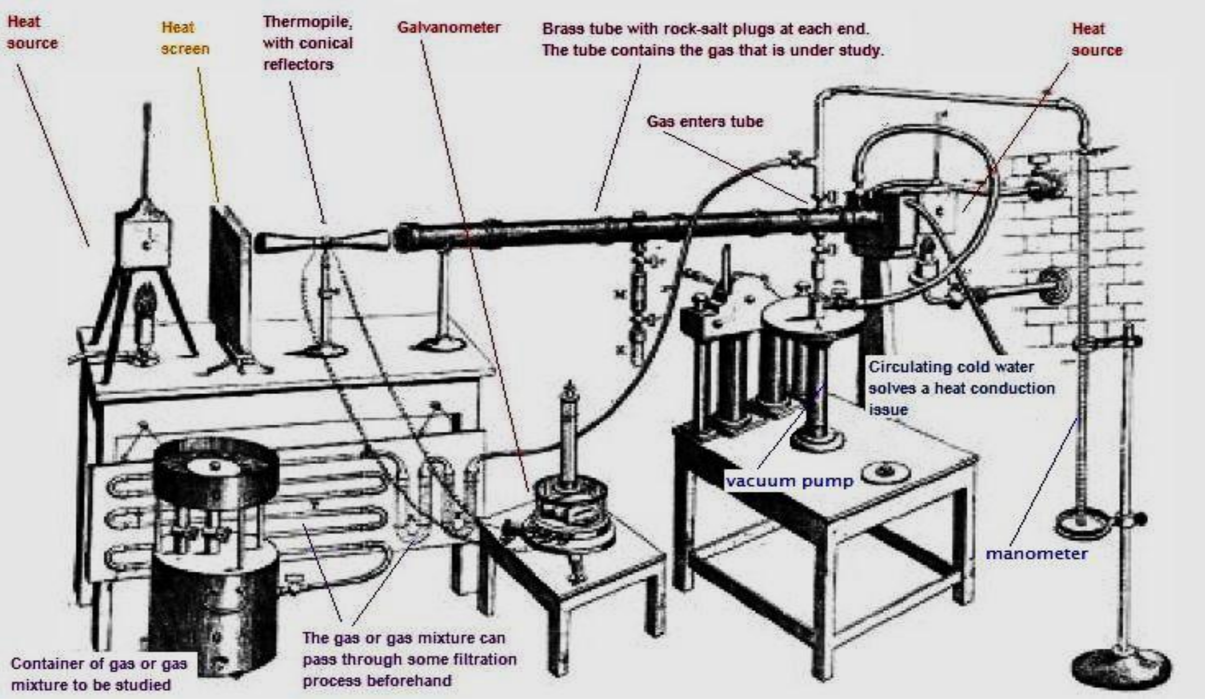
The wider acceptance of the phenomenon shall cause a major turnaround in the global economy and thus the resulting interventions shall largely affect the business performance of greenhouse gas emitting industries.

2.1 Evolution of Climate Science

The scientific assessment in atmospheric research roots back to early analyses of physics and geology. The stepping stone for the revolution in climate science was the idea presented by Jean-Pierre Perraudin, and other geologists, on the potentially changing size of glaciers. They supposed that there must have been glaciers which have been much larger than those seen in the Swiss Alps in the beginning of the 19th century (**Riebeek, H. 2005**). The idea arose through the potential traces of earlier glaciers, leaving behind glacial erratics that have been much longer than those remained in the Alps. The same area of study has been pursued by other scientists, such as Jean de Charpentier and Jens Esmark who all assumed that there should have been times when ice covered a considerable bigger part of the northern-hemisphere than it is seen present days. After a series of dismissal, Louis Agassiz a well-known scientist presented the idea of ice ages in 1837 to the broader scientific sphere (**Agassiz M. L. 1837**). What this invention meant for the science could not have been entirely realized that time. Even now days the glacier theory is fiercely questioned. Nevertheless, one could see that if there could have been an ice age than the Earth's climate may not always be a standard one as it is seen presently (or was in 1837) and thus it may change through centuries. Although the glacier theory is questioned, based on the evolution of scientific data collection it is surely seen that there were times when the climate was warmer or colder than it is today.

The next important step in climate science was the realization of the phenomena of solar radiation and its effects on the global temperature which is generally attributed to Jean Baptiste Joseph Fourier, a French scientist who investigated the laws of heat transfer and other physical and mathematical problems. His main realization was that the globe's temperature is higher than it shall be based on the irradiation of the sun and thus there should be some kind of trapping effect of the atmosphere that does not let the heat induced by the solar radiation escaping the Earth (**Burgess, 1837**). Based on his research Fourier defined the law of heat conduction or Fourier's Law. Based on his researches the definition of diverging effects of different gases on the air's temperature was established. His work has been translated by Burgess to English (**Burgess, 1837**) and further investigated by John Tyndall who could first scientifically address the heat absorption potential of different gases in the atmosphere. John Tyndall assembled a sophisticated instrument which was filled up with different gases and in open air because of the solar radiation the actual temperature change in the instrument could have been measured (**Jones, 1990**).

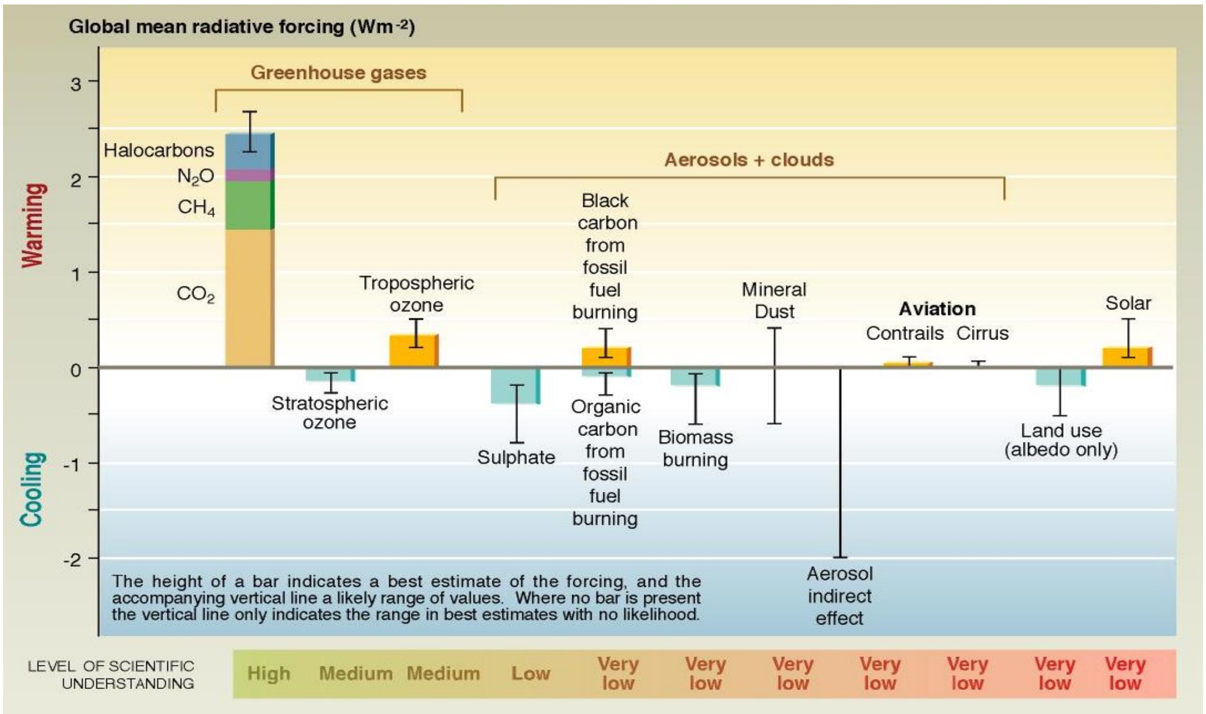
Figure 2: Illustration of Tyndall's instrument assessing heat absorption



Source: Tyndall

Surprisingly, not CO2 but water vapor has the strongest effect in absorbing the heat and thus water vapor has the higher warming potential on the temperature than CO2 has (**Tyndall, 1861**).

Figure 3: Anthropogenic and natural forcing of the climate for the year 2000, relative to 1750



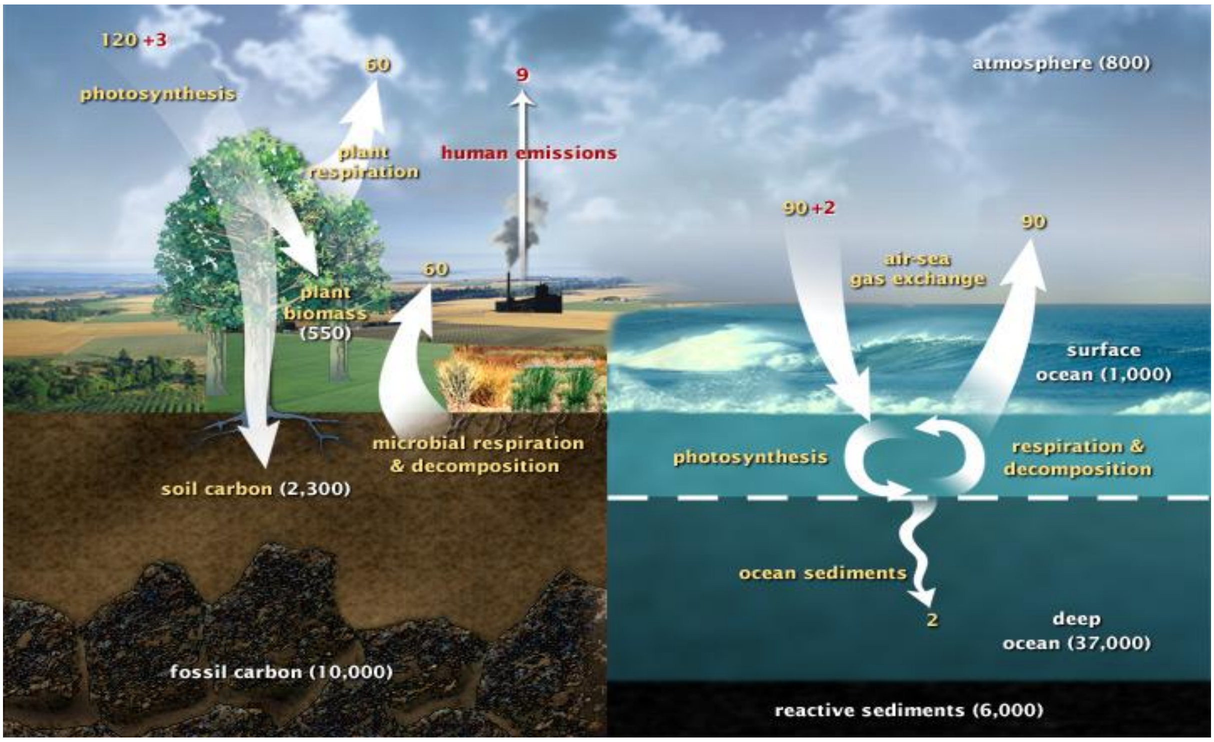
Source: IPCC

Based on the icebreaking work of these researchers it was already known in the 19th century that there are gases having an effect on the global climate that is largely similar to the mechanism of a hot or green house.

Svante Arrheinus has cooperated with Arvid Högbom for completing his assessments on ice ages. Höghborn had created a model of CO2 cycles taking into account all known sources and sinks of it (**Spencer, 2003**).

There have been a series of analyses focusing on the magnitude of warming potential of different gases since the invention of Tyndall. Based on these the above graph quantifies the potential effects of various gases on the change in the radiative forcing of the solar energy on the atmosphere. It is to be noted that although there have been a series of analyses concluded, because of the complexity of the climate and meteorology system of the Earth, a considerable level of uncertainty remains in quantifying the actual effect of several components of the atmosphere.

Figure 4:Global CO2 cycle (billion tons/annum)



Legend: natural fluxes (yellow), human contributions (red), stored carbon (white)

Source: NASA

Arrheinus has concluded that halving the amount of atmospheric CO_2 could result in 4-5°C temperature drop based on which he has found a plausible reason for the climate conditions resulting in the ice ages (**Arrhenius, 1896**). Höghborn has also calculated the magnitude in which anthropogenic emissions add to carbon dioxide levels of the atmosphere based on which Arrhenius concluded that there is an actual effect which through centuries may lead to warming. Arrhenius published a book (Världarnas utveckling) in 1906 which has been translated to English (Worlds in the Making) in 1908 where he suggested that the human emission of CO_2 could prevent the world from a new ice age (**Arrhenius, 1908**).

This book can be seen as the first stage of mainstreaming the climate change agenda. Interestingly, Arrhenius has seen this process as a positive one that is able to help the human society to avoid the next ice age.

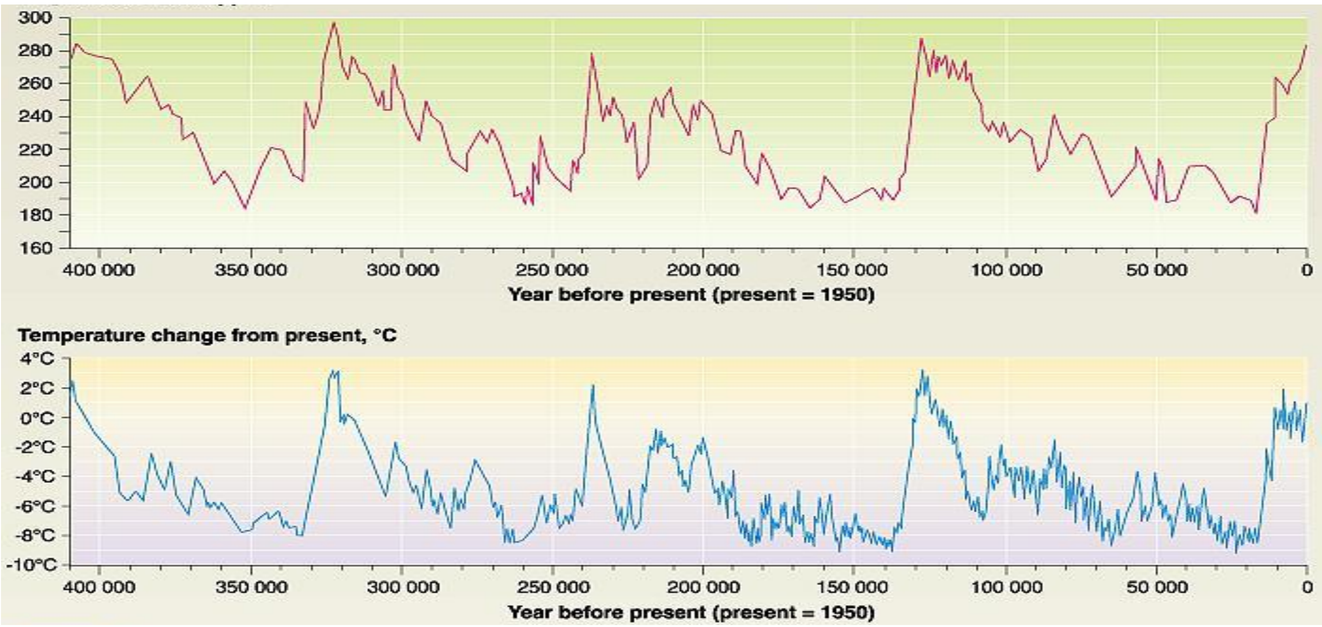
End of the 19th and beginning of the 20th century started a type of enlightenment in atmospheric science and initiated a fierce debate over the actual effects of our civilization on the globe's climate and meteorology conditions. Nevertheless, it is clearly seen that the evolution of atmospheric and climate science was and is not a self explanatory one. Because of the complexity of the climate system it is hard to reach common grounds for researchers and scientists.

The breakthrough of climate science can be assigned to the end of the 20th century. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) for drawing up the scientific background of the state of the climate. IPCC has published its first report in 1990, the so called First Assessment Report (AR1) in which it has been stated that "The potentially serious consequences of climate change give sufficient reasons to begin adopting response that can be justified immediately even in the face of significant uncertainties" (**IPPC, 1990**). The IPCC had a major role in turning the world around and has made the greatest achievement both in scientific and policy spheres by far with framing the idea, providing the scientific evidence and in giving digestible policy advice to decision-makers in understanding and handling the climatic challenges of the 20th and 21st centuries in a mature manner.

Climate change was and is a strongly debated sphere of science which has gone through a considerable transformation. Thanks to the efforts of the IPCC and other researches, presently it is scientifically accepted that climate change is happening that is inherent to human activities. There is a broadening scientific evidence of climate change, nevertheless science itself is changing, thus this topic also remains continuously debated and questioned. There are the so called climate skeptics who are unwilling to acknowledge the arguments put on the scientific agenda. The debate is welcomed from a scientific perspective and gives space for natural evolution of the concept.

It is self-explanatory that human activities are emitting GHGs. There is enough evidence that the level of CO_2 in the atmosphere has not been as high in the human history as it is presently (**Petit et al. 2001**). It has been proved by measurements executed on ice cores that the concentration of CO_2 has not been this high in the last 0,5 million years.

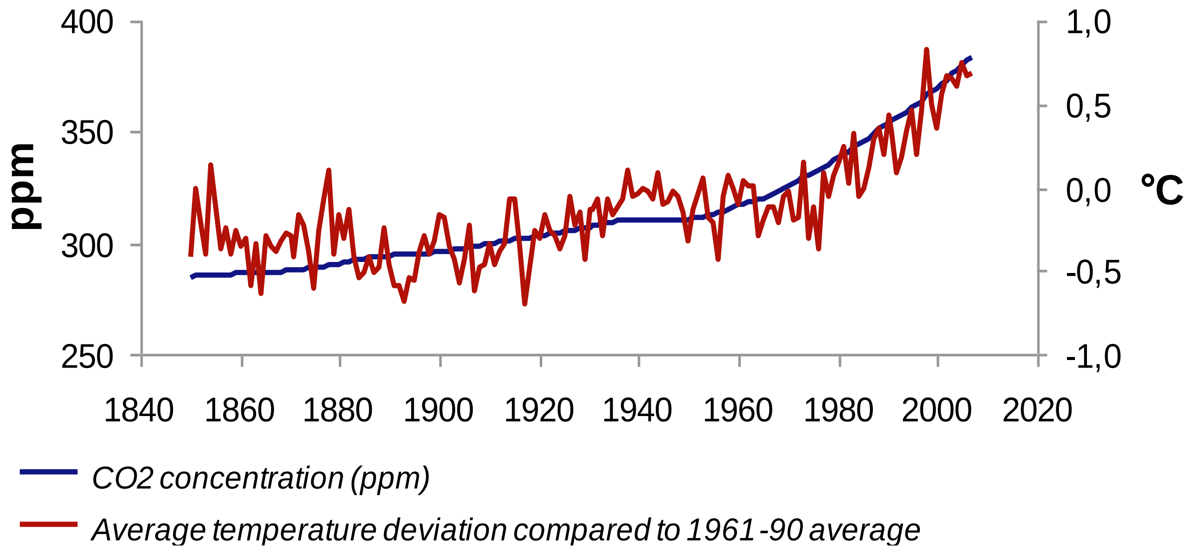
Figure 5: Temperature and CO2 concentration in the atmosphere over the past 400 000 years from the Vostok ice core (ppm)



Source: Petit et al.

There is a series of evidence already presented that the elevation of the CO2 levels leads to modification of the warming potential of the Earth (**IPCC, 2001**). Thus based on the precautionary principle the reduction of anthropogenic GHG emissions shall be limited.

Figure 6: Temperature and CO2 concentration



Source: Own figure based on UNEP

Based on the above described data there is evidence that the composition of the atmosphere is changing which needs to be addressed by the international community.

2.2 Economy Theories Applicable to GHG Emissions

The way in which policy and decision makers approach environmental issues, including greenhouse gas emission, has been always closely related to the foreseen effects on the economy. Addressing potential effects of policy interventions in the environmental sphere the main economy theories have to be applied to the matter of anthropogenic greenhouse gas emission.

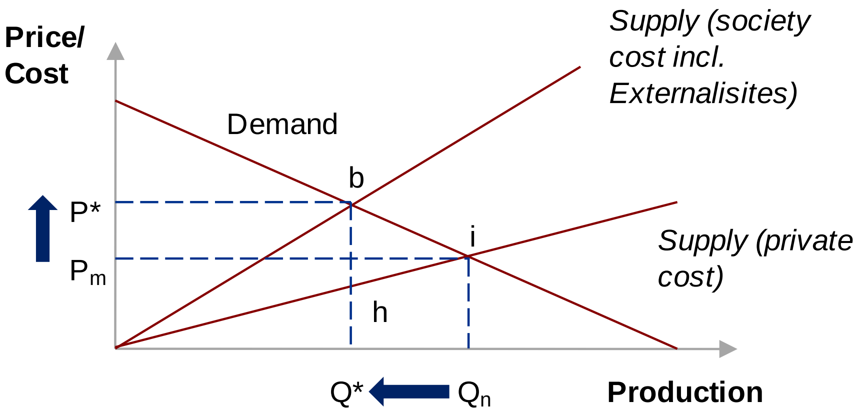
Based on the concept of market wisdom developed by Adam Smith the market reaches the its equilibrium without any governmental interventions and reaches it in the most effective way because of the rational cost minimizing and income maximizing strategy of each participant (**Smith, 1776**).

Ronald Coase introduced the concept of optimal level of pollution which is balancing between the costs of pollution and the incomes generated to cover the costs of pollution. He argues that intervention is not necessary for environmental protection because based on the concept of Adam Smith the market will reach its equilibrium without external intervention; nonetheless he argues that reaching this equilibrium is ultimately subject to the establishment of property rights of each market actors and facilities (**Coase, 1960**). As the property rights in the case of the environment and all of its substances including land, water and air are not set, based on the argument of Coase, the market is unable to reach its equilibrium. Thus a point of environmental market saturation when the incomes generated match the costs of pollution cannot be reached.

Another aspect of the free market is that if not all participants are covered by certain factors then inequities arise that put constraint on several market actors which will suffer from the intervention and those which are not covered by the policy will enjoy advantages. This results in deviations of the market which may impair the efficiency of any regulatory intervention.

Alfred Marshall investigated the topic of market equilibrium and concluded that supply and demand reaches the equilibrium as a function of price and quantity which depend ultimately on the total costs of production and on the level of market demand. He further investigated the issue and identified that not all costs are covered in the present economy structure and has named those unaddressed cost as external costs of industrial production. These costs are not shown in the direct costs of production and thus are neglected when the market reaches its equilibrium. Marshall’s recommendation was to internalize the external costs of production based on which a new equilibrium is to be reached in the free market described below with (Q*;P*).

Figure 7: Representation of economy supply-demand equilibrium



Source: Own figure based on A. Marshall

Arthur Pigou claimed that because of the mentioned deficiencies an overall burden should be introduced on the producers which is able to cover the externalities of production, namely the costs of environmental pollution (**Pigou, 1932**).
This discussion is not over yet, there are pros and cons for each of the recommended intervention. The European Union (EU) has decided for Marshall’s approach when introducing the cap and trade system in emission trade. National governments tend to make use of Pigou’s recommendations and introduce standard taxes on polluting industries. Ultimately, environmental economics investigate the ways in which the external costs may be internalized.

Short conclusion: Costs of production in environmental economics

External costs are partially or entirely neglected in the present economy system which among others results in environment degradation. Two main options to internalize the external costs are taxing and/or introducing market based instruments, such as cost elements prescribed in emission trading.

3 METHODOLOGY

Such methods are used in the dissertation which are adequate to review and assess the status quo of the emission trade market and based on these provide recommendations to enhancing future emission trade systems. Three main hypotheses have been defined:

I. There are defects in emission trading systems which hinder the cooperation addressing climate change and the actions mitigating anthropogenic GHG emissions.

II. A common multinational emission trading system has diverging or contra productive effects on entities which are unable to relocate, e.g. in the case of the power generation sector which experiences regional fuel price differences

III. A GIS type of intervention and a balancing mechanism introduced to the power sector is capable of reducing the space to unfair practices, ensure that externalities of production are covered, increase the competitiveness of cleaner power generation, and help the widespread of alternative energy sources

Ultimate target of the dissertation is to provide applicable solutions to mitigate negative effects of the deficiencies in the regulation and operation of emission trade systems.
To serve the needs of the ultimate target of the research different tools and strategies are to be made use of which entail background desk research, interviews, participatory observation, case study development and last but not least the development of two own models in MS Excel which are able on the one hand to address the defects of present emission trade systems, and on the other hand establish the basis for a balancing mechanisms that smoothes out these negative effects. Consequently, the model and resulting recommendations are crucial to the successful operation of a potential future global universal emission trade system.

List of the main methodologies and approaches utilized in the dissertation:

1. *Literature review*
2. *Media watch*
3. *Desk research in the case of investigation on criminal and unfair practices*
4. *Interviews*
5. *Participatory observation*
6. *Typology development of unfair practices on the basis of the investigation*
7. *Model development 1: assessment of the effects of regional fuel price differences in case of multinational emission trading systems and their effects on GHG emission mitigation*
8. *Case study development and evaluation in relation to the experience of the Hungarian Green Investment Scheme (GIS)*
9. *Model development 2: costs and benefits of the Hungarian GIS programs*
10. *Development of an own proposal for a reformed multinational emission trade system*

The research heavily builds upon primary and secondary sources of literature which provide two of the main sources of information. A literature review provides the basis for the description of the scientific roots, economy theories supporting climate change phenomenon, and a policy analysis detailing the regulatory background and operational rules of emission trade. Literature sources are heavily used in the field of climate change, related economy theories, and potential ways in the application of business logic to the climate agenda. Interviews meant major help in addressing practical issues of emission trade which could not have been identified from literature sources. These inputs and analyses are all assisting the understanding of which alternatives are available to GHG emission mitigation practices also from the perspectives of economics.

Primary and secondary sources are available for the study that eased the delivery of the targets of the dissertation. A paramount sphere of the literature secondary sources has been gathered through media watch. Media watch is a crucial corner stone of the study in the field of fraudulent and unfair practices. The researcher has been collecting targeted newspaper articles, professional or non-governmental organizations' (NGO) publications, and outcomes of conferences. Since 2010, all major international journals and emission trade related publications have been monitored and in case of fraud related headlines they have been archived for evaluation. Only those areas are assessed and analyzed in detail which can have major effect on the operation of emission trade market and on the effectiveness of carbon emission reduction initiatives.

Participatory observation has been used to complement the findings of the literature review and interviews. As it has been put *"Observation, particularly participant observation, has been used in a variety of disciplines as a tool for collecting data about people, processes, and cultures in qualitative research."* (**Kawulich, 2005**). The analysis of the defects of emission trade required the utilization of the method to *"access to the backstage culture… improve the quality of data collection and interpretation and facilitates the development of new research questions or hypotheses"* (**Kawulich, 2005**). Although participatory observation has been primarily mainstreamed in anthropology, social, and psychology sciences but rarely in economics there have been straightforward reasons it has been identified as a sound methodology tool for the present analysis:

- emission trade is a new regulatory system & business;
- the business arena of emission trade is somewhat closed to the general public;
- although the scientific arena is open to the general public the topic was too complex and much debated that hurdle the understanding of the system;
- there are a number of assessments done in the field of emission trade but none of them had the particular focus on the defects of the system;
- the term "defects" in emission trade engages into a swampy area of research because of the fact that even just the presence of the analysis may have immediate negative effect on market prices.

Because of the issues raised above it has been identified more efficient from the study perspective to use at certain points of the research the tools of observation rather than to conduct formal interviews.

The methodology serving the execution of the analysis comprises traditional tools and approaches which form the basis of an unconventional approach framed by the researcher as investigative analysis.

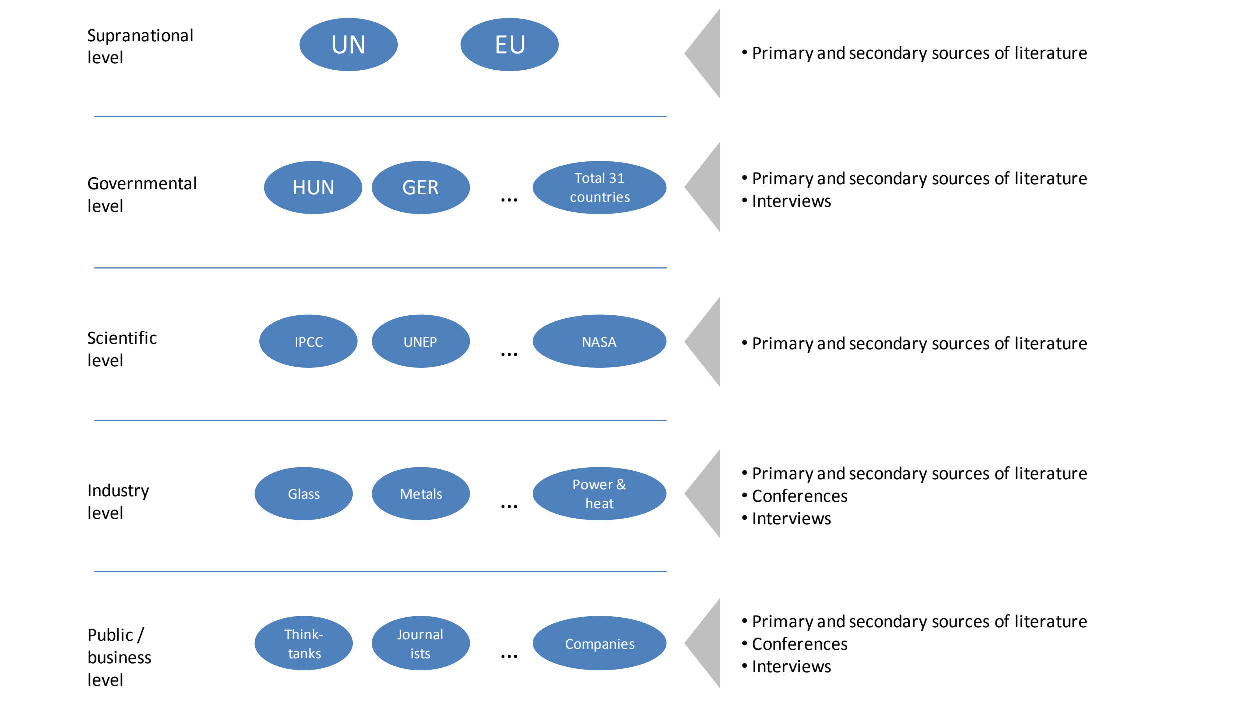
Investigative analysis has been widely used in the case of investigative journalism. As Nils Hanson has put it investigative journalism has the following qualities:

- *"Critical approach - focus is on what does not work and in one way or another can be described as anomaly.*
- *Important subject - only a question of importance for the common good can motivate the amount of effort and resources, that very well may have to be invested in the research as well as the criticism uttered in the publication.*
- *Own initiative - journalists/editors decide, what is important.*

- *Own research - the reporter gathers information and documents, sometimes in spite of tough resistance.*
- *Own analysis - the information gathered and the documents are evaluated. An expert can assist in the analysis, but publication does not depend on what someone says.*
- *Exclusivity - the public learns important information, that else would not have been in the open."* (**Hanson, 2009**).

The present analysis has analogies with investigative journalism but with the caveat that the general rules of scientific analysis have been continuously monitored and maintained throughout the research. Further to that, the researcher provided the required expert knowledge throughout the study and external assistance has been only obtained through the interviews.

Figure 8: Stakeholder levels and the main methodology tools addressing the areas of climate change and emission trade



Source: Own figure

Based on the findings of the literature review, interviews and policy analysis multinational emission trading has been portrayed. Based on the analysis of the philosophies of precaution and sustainability the actions targeting GHG mitigation have been confirmed. The investigative analysis put light on a list of issues which are contradictory to the above mentioned philosophies. These have been structured under the defects of emission trade.

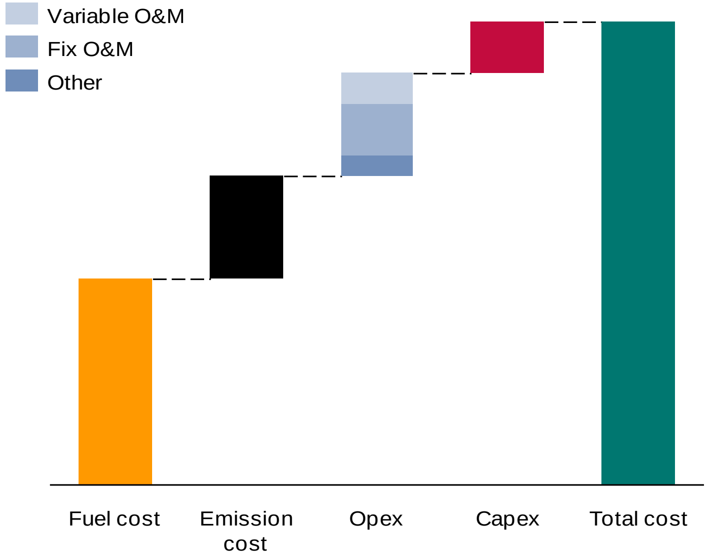
There are defects identified in the research which with more or less regulatory intervention and policy formulation can be overcome in the short run and thus allow the ease of acceptance of future emission trade systems and improve their effectiveness both in financial and environmental spheres. But there are defects which need in-depth analyses and deep investigation to be addressed effectively. Identified defects are qualitatively assessed and described and quantitatively addressed. The quantitative assessment targets to address numerically the fraudulent activities and their results on the operation of multinational emission trade systems. The qualitative and quantitative assessment are the ultimate results of the investigative analysis in emission trade based on which an own typology of these practices has been developed. The analysis of identified defects provides the grounds to forming recommendations to the development and enhancement of future multinational emission trading regimes.

Two own models have been developed as research additions in the dissertation:

1. The first model is developed on the basis of a linear equation in the marginal costs of power generation as a factor of different CO2 cost levels. The linear equation and the programming of the model have been developed throughout the research. The linear model has been programmed in the potentially simplest way in MS Excel having good potential to derive sound numerical results for the case of regional fuel price differences in emission trading regimes. Secondary sources provide the inevitable input data to the model (e.g. fuel costs).

From a policy perspective, based on the applicable economy theories, it is a sound intervention to prescribe a standard CO2 burden on all greenhouse gas emitting industries. This approach is clear and straightforward which also takes into account the business perspective that always searches for the financial rationality in policy targets. From a financial perspective the decision on business continuity depends on the financial performance of the operator. Loss making businesses cannot be sustained for a longer period of time. The effect of the CO2 burden in respect to the profit generation potential of the operators is decisive. When analyzing the actual cost structures of power generators apart from the CO2 costs included in the variable costs of the company, fuel costs have a decisive role in respect to the profitability of the power generator as it is illustrated on the bellow figure.

Figure 9: Assessment of the cost structure of power generators



Source: Own figure based on business planning basics

Fuel cost is different for different resources and the emission factor is also not the same of different fuels. This means that a fuel which is cheaper can have a higher emission factor and the cost of the generated electricity may be competitive in contrast to a fuel that is more expensive and has less related emission. This results in a natural evolution of the power sector which entails an economic optimization process that brings more and more less GHG emitting participants above the water parallel to increasing price of CO2 emissions.

This part of the study focuses on the cost structures and financial performance of power generators in view of regional fuel price differences in the EU and worldwide. The study of cost structures of different regions is to highlight the difference of power generation marginal costs resulting in diverging effects on CO2 abatement of power plants. Based on this finding a global perspective is to be structured with an analysis of different regions of the world. Based on the modeling task the inequities of a standard CO2 price system are portrayed. The dissertation highlights that a standard CO2 cost burden either through taxing or emission trade may hinder the decarbonization of regions that would mostly need the transformation of an old, inefficientn and carbon intense energy sector. The model is able on the one hand to describe the financial consequences of the defects in climate conscious energy sector development and on the other hand establishes the need for a balancing mechanism which introduced ex post would be able to balance out the negative economy effects of the defects and thus increase the operation efficiency of emission trading systems. This part of the research is partially based on secondary sources of data providers. Main data sources are professional data providers, such as Bloomberg that is able to provide the input data to the model, e.g. fuel prices. Secondary sources for the modeling inputs are derived from professional entities or international organizations, e.g. IEA, Eurostat, KPMG, to provide the assumptions on the actual cost structures of power generators (Operating expenditures, OPEX division). One of the scientific additions of the study is the model (see Annex 1) that describes the effects of fuel price differences on the marginal cost of CO2 emission for different power generators. The detailed modeling steps are described in the chapter on regional fuel price differences.

The power sector is a purposeful selection as the power sector has a limited geographical scope. Almost every industry is able to relocate in the interest of cost optimization meanwhile this is not the case for the power generation sector. Power transmission has its limitations on the side of long distance transportation and resultantly needs to be on site in every country. Further to the transportation bottlenecks, the availability of a strong power generation industry is a key energy security issue for all countries. Because of these the power sector is in a special situation having limitations which are contradicting to the general logic of emission trade echoing that it is the best and the most cost efficient market based tool in the field of climate policy to reduce GHG emissions.

2. The second model was developed to analyze the costs and benefits of the Hungarian Green Investment Scheme (GIS). Primary sources of the Ministry of Development are heavily utilized in connection to the development of the case study of the Hungarian GIS and in the modeling efforts developed based on the data collected through the case study.

The main sources of information for this part of the study are gathered through an interview and the publications of the Ministry's Climate Unit. Secondary sources are limited in the field of GIS but out of the few the Central European University has its contribution in this field too (**Tuerk, 2010**).

Regulatory basis of IET and GIS are described through a literature review. This part of the case study is crucial in understanding the basis of IET as one of the flexible mechanisms of the Kyoto Protocol. Another part of the literature review details the background of the Hungarian approach to the IET. Based on the background provided by the literature review and an interview the case study of the Hungarian IET has been developed.

Yin presented four main reasons of case studies:

1. *"explaining complex causal links in real-life interventions*
2. *describing the real-life context in which the intervention has occurred*
3. *describing the intervention itself*
4. *exploring those situations in which the intervention being evaluated has no clear set of outcomes"* (**Yin, 2003**).

The case study is crucial in understanding what the main expectation of buyers and sellers are in IET activities. Thus based on Yin's reasoning the 2nd point, meaning the description of the real-life context is paramount to the dissertation. The case study is then complemented with the third part of the literature review in the field of the implementation experience and description of the operation of the Hungarian GIS system. In relation to Yin's reasoning the literature review is to complement the case study with the 3rd point, namely detailing the intervention itself. The target of the case study and the literature review is to highlight the advantages of the GIS compared to the other two types of flexible mechanisms of the Protocol, namely Joint Implementation (JI) and Clean Development Mechanisms (CDM) which are both project based interventions in contrast to the national level of intervention of the GIS.

Literature review, media watch, interviews, case study development, and the two modeling efforts are synthesized in the final part of the research that servers the ultimate goal of the study to provide solutions to post Kyoto climate cooperation with an enhanced operational effectiveness. This is achieved through the conceptualization of a renewed system that excludes the presently observable unfair practices which result in windfall profits to some of the stakeholders lacking the real target of climate change mitigation efforts. This final part of the study combines the conclusions of each of the chapters of the research and draws up a recommendation for enhanced operation of emission trade.

3.1 Aims and objectives

The analysis builds on the findings of researchers, philosophers, economists, and scientists working in international organizations such as the IPCC, UN, WMO and EU. The dissertation portraits actions which may assist strategies combating climate change. If they are incepted based on the available scientific evidence or based on the principles of precaution and sustainability reforms to the climate cooperation are unavoidable. It was not the goal of the research to prove or reject the phenomena of changing climate. Hence, it was not a goal of the study to persuade the reader to believe in climate change. But when international systems are introduced and maintained it is all of our interest to make them capable of the best addressing issues of climate change. Above all, the dissertation is to build upon the understanding of the Kyoto and EU ETS systems and identify where space for improvement remains.

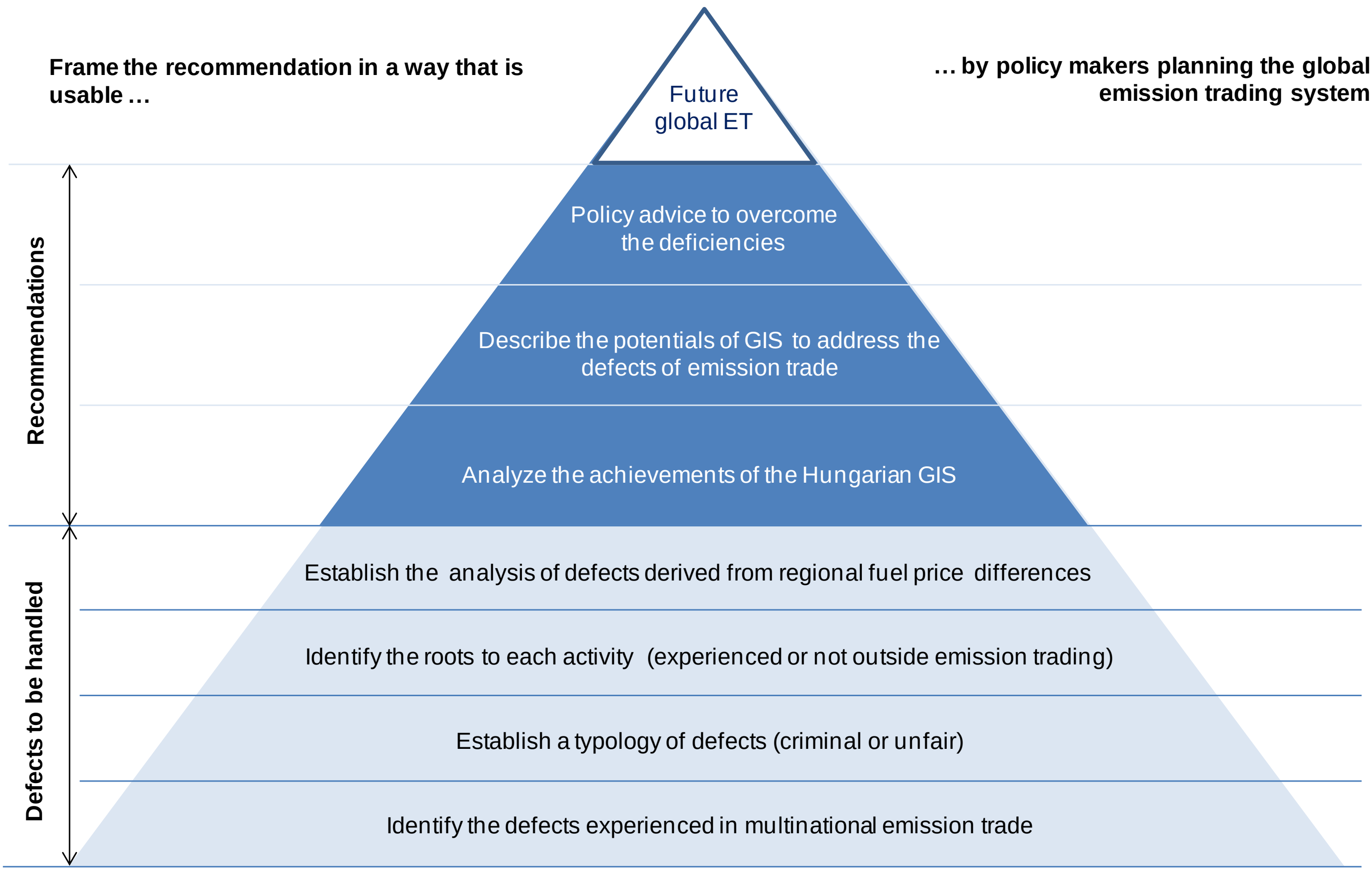
For the purpose of achieving the aim of the research several sub-aims are defined and structured in a bottom-up strategy to achieve the ultimate target of the dissertation:

1. Identify the experienced defects of operational emission trade systems
2. Establish a typology of experienced defects in emission trade under two main divisions of
   - criminal and
   - unfair practices
3. Investigate the roots to each defects of emission trade under two main divisions of
   - experienced only in emission trading or
   - a known practice that have been reproduced in the context of emission trade
4. Establish the framework for analyzing the effects of regional fuel price differences in multinational emission trade context (including the development of a model which is able to quantify the consequences of fuel price differences)
   - assess the effects of CO2 costs on power generators (coal and natural gas fuelled representing the two ends of fossil fuels in terms of carbon intensity);
   - provide an assessment on the potential negative effects of the fuel price difference on the decision of power generators in the field of CO2 abatement
   - policy recommendations;

5. Analyze the achievements of the Hungarian Green Investment Scheme
   - detailed description on the experience of the Hungarian IET activities and the GIS;
   - description of the main expectation of the trade participants;
   - main lessons learnt through the Hungarian experience;
6. Describe the potentials of Green Investment Scheme as a tool to enhance future multinational climate protection activities
   - describe the advantages of GIS compared to the project based flexible mechanisms of the Protocol;
   - recommendations to be developed for future reformed GIS activities.
7. Provide policy advice and regulatory recommendations to overcome each of the defects of multinational emission trade
   - synthesize all the conclusions of the investigation, analyses and modeling tasks;
   - describe the potential ways (policy/regulatory) in addressing unfair and fraudulent activities in emission trade;
8. Frame the recommendations in a way that allows policy- and decision-makers to make use of those when progressing to a common global level emission trade regime
   - evaluate the prerequisites for the successful operation of the reformed IET and GIS;
   - describe the potential of the IET and GIS system in addressing fraud;
   - detail a reformed system which takes into consideration the effects of regional fuel price differences of power generators and fraudulent activities in multinational emission trade context.

The objective and the 8 sub-objectives are structured in a logic pyramid where each stage builds upon the conclusions derived from the previous levels. Objectives are structured to grab together the experienced defects, provide tools to overcome them, and describe a renewed framework which can deteriorate the space for inefficient, contra productive and unfair or criminal activities. It has to be emphasized that not just those activities are under scope which are criminal and need police or tax authority attention but all of the practices which do not add environmental value but provide space to generating sole financial profits without respect to real environmental protection activities and resulting GHG emission mitigation.

Figure 10: Logical pyramid of the study objectives and goals (bottom-up approach)



Source: Own assessment

Aim of the research is to provide a utilitarian recommendation to the regulation of emission trade market meaning which allows the greatest benefit to the environment and the population. As Jeremy Bentham has put it defining the utilitarian philosophy "*it is the greatest happiness of the greatest number that is the measure of right and wrong*" (**Bentham, 1776**). Multinational emission trade shall be a phenomenon that serves the needs of the many in contrast to the few who benefit from environmental degradation or the profits derived from the negative externalities of GHG emitting activities. Further to this, emission trade must have the feature that it serves the needs of the most with prescribing the least cost to the economy on the way of GHG emission mitigation. In this way, those entities which might suffer from environmental regulation may suffer the least from facing the potentially smallest financial burden on their harmful activities.

It is the right timing to present the findings of the research to the global scientific and business arenas in view of the questionable success of the latest climate conferences. Although, in 2013 the second commitment period of Kyoto has been inaugurated the pledges and commitments are questionable which has undeniably degraded the trust in the system. The main reasons for failures in international negotiations are heavily connected to the defects of emission trading that are to be addressed thoroughly in the dissertation.

With achieving the study objectives the policy and decision making spheres will have a more comprehensive understanding of the underlying issues around climate policy & regulation that shall ease the consensus progressing to a future global climate regime.

3.2 Contribution to knowledge

In the last two decades the scientific knowledge in the spheres of climate change and carbon dioxide management has gone through a considerable evolution. There have been a number of publications which focused on different spheres of the phenomenon. Nevertheless, a comprehensive assessment of the emission trading regime, its effects, and main defects which can also provide recommendations to future efforts of the international community combating climate change has not been compiled.

Based on the research of history of climate change phenomenon a confirmation of policy actions targeting climate conscious economy development is anticipated. It is not the target of the research to confirm or reject climate change but to assess the potential of policy & regulation in addressing it. On the grounds of the history the actions curbing greenhouse gas emissions initiated by far are to be displayed which are also evaluated in the view of applicable economy theories. This part of the study confirms the relevance of the introduction of emission trade system in the field of climate policy. Meanwhile skepticism may prevail based on the uncertainties deriving from the complexity of the globe’s climate system and the limitations on the scientific knowledge the interpretations of sustainability and precaution are anticipated to provide a sound argumentation for the confirmation of a climate conscious economy development path. The Intergovernmental Panel on Climate Change (IPPC) has done an unprecedented effort in building up a network of scientists and researchers to understand in detail the effects of human activities on the climate system and to provide understandable messages to policy and decision makers. The present study endeavors to contribute to the scientific reports including the IPCC's Assessment Reports published by now by addressing the business and economy level effects of climate conscious development paths. The present study evaluates how policy & regulation may shape the future of actions combating climate change.

Two main shortages are to be explored in the case of operating emission trade systems and international cooperation. On the one hand in the case of the Protocol and ETS their ability of deteriorating fraudulent activities or unfair practices and on the other hand in the case of multinational emission trade systems the defect in addressing regional fuel price differences. It is expected that without diminishing unfair practices no global intervention may have a long lasting effect in the field of climate conscious development. It is also anticipated that an assessment of the effects of regional fuel price differences results in the confirmation of the deficiency of a standard CO2 burden to accelerate the decarbonisation of underdeveloped regions. Further to this a detailed assessment of the power generation sector establishes the grounds for future policy interventions which are inevitable for planning the actions post-Kyoto. The effects of primary energy price differences on the power generation sector of the EU ETS are to be modeled through benchmarked power plant data and a fuel price dataset. The modeling task is primarily focusing on the power generation sector and ultimately to the planning of a global emission trading system which deteriorates the space for the present defects in emission trading regimes.

Another focus of this study is the mechanism of Green Investment Schemes (GIS). Very limited number of studies dealt with the issue of GIS and thus the system has serious issues with transparency and viability. Further to this, the maintenance of the system has uncertainties as the latest climate negotiations did not give final decision on the carry over of the Assigned Amount Unit (AAU) surpluses for the second commitment period. A series of CEE countries have been involved in international emission trade from which the Hungarian experience is evaluated in a detailed case study that is capable of providing usable methods for market based interventions post-Kyoto. The case study of the Hungarian IET and GIS is to provide usable strategies to policy makers in developing any future intervention, especially multinational emission trade. It is seen that the IET backed up with a GIS provides a sound market based policy tool to smooth out any discrepancies in an emission trade system including the case of regional fuel price differences and unfair practices.

Overall logic of the study is to build upon the knowledge available in climate science, analyze the experience gained through emission trade and establish the grounds for reformed climate cooperation. The ultimate target of the research is to provide applicable solutions to policy and decision makers to implement such reforms which are able to erase the defects of presently operational emission trade systems especially, unfair practices and regional inequities resulting from fuel price differences.

3.3 Limitations of the research

The aim of the research is to provide solutions to the experienced defects of multinational emission trading systems. Defects are analyzed in detail to provide applicable solutions to them which are also usable by policy makers. Because of the target of the study a differentiation was needed to establish the framework of the investigation. Because of the fact that many of the unfair or criminal practices are not only related to the emission trading activities but are well known to policy and tax authorities in general these activities have been omitted. The only common law crimes included in the research are the cyberthefts and VAT fraud which both caused particular damages to the system.

Common law crimes excluded from the research are:

- corruption cases
- violent crimes
- robbery, etc.

Common law crimes included in the research are:

- cyberthefts
- VAT fraud.

Although it is evident that common law crimes had their role in the case of emission trading in general, their solutions mostly do not lay in the sphere of climate policy but in general police and governmental investigations. A clear example of such activity that has not been further analyzed in the research was a Hungarian one in which case it is claimed that someone in the staff of the Ministry of Environment had committed signature forgery to help a company receiving freely allocated emission quotas (**VG, 2012**). Cyberthefts and VAT fraud are included in the investigation because on the one hand they meant one of the biggest financial losses to the system and on the other hand they seriously degraded the belief in the operation of emission trade having long lasting negative effects on the establishment of a global emission trading system.

Next to the fraudulent activities the regional fuel price differences in the power generation sector have been identified having serious negative effects on the operation of multinational emission trade systems. For the purpose of creating a modeling framework the marginal cost approach has been implemented.

The model is limited to the:

- power generation sector.

The power generation sector provides a sound comparative basis for the analysis as it sources the needed energy to most of the productive sectors of any economies and is a product that cannot be substituted in residential, public, or commercial energy consumption.

The MS Excel model has been built up in a way that is able to quantify the differences in the breakeven of cleaner natural gas based power generation compared to the dirtier coal fueled power generation. For the purpose of sound and visible results the model provides country and fuel level comparisons only.

The model is limited to:

- fuel and country level comparisons.

A more detailed power plant level assessment shall be a potential for further investigation in the field of fuel price differences. An important field of further analyses could be also the case of different renewable energy sources in the power generation sector. The model is capable of describing the breakeven for different types of renewable power generation technologies as factor of CO2 prices compared to fossil fueled generation. This study could bring useful results in the field of combining the CO2 and renewable energy support schemes which operate parallel and uncoordinated

present days. Nevertheless, the researcher sees as it is a more urgent need to address the issues in the traditional power generation sector. The alternative power generation technologies may follow in a next study building on the available MS Excel model.
Further to these, the marginal cost approach could be applicable for analyzing any other sector of the economy and especially different spheres of industrial production which can also be further studied in detail based on the established modeling framework.
All of the further modeling activities would require extensive further data collection and quantitative analyses of model results.

3.4 Ethical considerations

Based on the Code of Ethics of the Central European University the following considerations have been identified with general applicability to the research:

"Acts of General Misconduct

1. The offense of general misconduct includes:

(a) violation of University regulations and policies;

(b) knowing disclosure of false information to the University or to other academic institutions; …

Article 29

Acts of Academic Misconduct

1. The offense of academic misconduct includes: …

(b) the representation of the work of others as one's own, including plagiarizing the ideas or words of another without proper attribution to the source of those ideas or words, whether intentional or not;

(c) the intentional misappropriation of another person's academic materials without that person's permission;

(h) action or inaction which is offensive to the integrity and honesty of the community or any of its members;" (**CEU, 2013**).

The present analysis is free from any breaches related to the Code of Ethics of the CEU.

Based on the Ethical Research Policy and the Ethical Research Guidelines of the CEU the following aspects have been identified with central importance to the ethical considerations of the research:

- *Obtaining Consent*
- *Research in Public Contexts and With Groups*
- *Confidentiality, Anonymity and Privacy* (**CEU, 2013**).

As discussed in the methodology chapter a mixture of tools has been utilized to serve the needs of accomplishing the aims & objectives of the study. All in all, consents of interviewees have been obtained from participants listed in the references, under personal communications in formal interviews. Consents of each stakeholder have not been obtained in case of bigger group discussions in cases of conferences or workshops. It was a primary target in each of the informal discussions to let the participants know the researcher's intention to collect information to the prospective PhD dissertation entitled to the defects of emission trade systems. Interestingly, after disclosing the above short introduction, stakeholders became especially interested in the topic and were ready to provide their views on the issues surrounding their activities in emission trading.
In the case of informal interviews/discussions and in general for the method of participatory observation the anonymity of participants has been secured throughout the research.

4 LITERATURE REVIEW

The analysis grabs together all of the influential scientific, regulatory, policy, economy, and technology related concepts in the field of climate change.

4.1 Sustainable development and the precautionary principle

End of the 20th century brought new approaches into focus in economy development and environmental protection. The concept of sustainable development has been incepted by the United Nations (UN) in the report Our Common Future compiled by the World Commission on Environment and Development which since its publication in 1987 has embraced all development strategies throughout the globe. As described in the report "Our Common Future" sustainable development entails:

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (**Bruntland et al. 1987**).

The concept is nearly self explanatory, nevertheless it is also revolutionary because it has brought a type of enlightenment to the social and economy development policy agenda at the end of the millennia. The concept is revolutionary because it claims that the present generation is capable of prejudicing the future generation's economy and environment. Earlier the understanding was that the human intervention into the Earth's ecosystems and environment are such minor that they are negligible and the Earth is able to remedy itself from the pollution and harmful changes.

There have been cases when environmental pollution have caused deaths or impaired health state of the citizens but these have been considered rather local issues. The industrial revolution and coal as the main source of energy considerable increased air pollution which amplified by the metrological conditions resulted in some unprecedented events. Overseas the smog problem has been realized in the beginning of the 20th century on July 26, 1943 the smoke in Los Angeles limited visibility to three blocks and resulted in very unpleasant irritation to the population (**Los Angeles**

Country Board, 1997). Based on the analyses of the issue the Los Angeles County Air Pollution Control District has been brought to life in 1947 that was the first system limiting the air polluting activities of industries.

There have been other cases of air pollution which have called major attention to the topic in Europe. The London smog was an unprecedented event in Europe, December 1952 (**Bell M. L.et al., 2004**). At that time citizens of London did not see the event as a catastrophic one but based on mortality assessments the five day-long smog resulted in excess death of 3-4 thousand that have been reported by hospitals after the event. Bell argues that this event had a longer effect then a few days and based on his analysis about 12 thousand people have died till 1953 as a result of the smog. The event has called major attention in Great-Britain and around the world which resulted in the first Clean Air Act of England in 1956 (**Guissani, 1994**) focusing on the emission regulation of industries. The case of the London smog called the attention of the European society and also the scientific agenda that the human caused hazards are capable of threatening human life and cause enormous health defects to the wider population.

These unprecedented events, among others, have played important role in paving the way for the concept, sustainable development. The policy, industry and society spheres have undergone a crucial change in the last fifty years which allowed the acceptance of the fact that anthropogenic influence and especially atmospheric emissions are changing the living conditions of the population and can have serious health effects. Addressing these problems, sustainable development not only takes into account the future generations' abilities but our present generation's ability to serve its needs as the previous generation could do it.

Parallel to the concept of sustainability the notion of precaution has evolved. The role of proactive action in environmental protection has gained major importance by the Rio Declaration on Environment and Development and the Maastricht Treaty establishing the European Union. They prescribe the role of precautionary principle as the basis for environmental protection in the planning of economy and human development.

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities." (**UNEP, 1992**);

"Community policy on the environment, ... , shall be based on the precautionary principle and on the principles that preventive action should be taken, that

environmental damage should as a priority be rectified at source and that the polluter should pay." (**Maastricht Treaty, 1992**).

Although neither the UN nor the EU gave a detailed explanation of the term "precaution" based on Timothy O'Riordan's and James Cameron's definition precautionary principle in environmental protection and economy development requires careful action where scientific evidence proves that inaction for environmental protection may lead to harm to the environment and to the future generations (**O'Riordan, Cameron, 1994**). Enhancing the core message of the principle, scientific uncertainties have been taken into account which has been emphasized by the World Commission on the Ethics of Scientific Knowledge and Technology pointing out those unpredictable and uncertain but potential risks of development which made it necessary to develop an approach that is capable of effectively addressing the uncertainties and mitigate the risks of damage to human life and the environment (**WCEST, 2005**). Sustainable development and the precautionary principle are complementary in their approach addressing the right of the future generations in fulfilling their needs at least at the same level as the present generation does that might be impossible when permanent damage has been done to the environment in case of neglecting the precautionary principle.

Principles of sustainability and precaution affect all human activities, such as urban life, communities, social development, state of the economy and scenarios of development, etc. by prescribing liabilities of each stakeholder to act in a manner that does not jeopardize the abilities of societies', future generations' and the state of the environment neither at present nor in the future. Based on the definitions of the two principles climate change agenda embraces both, i.e. changes in climate conditions either temporary or permanent puts the future generations' abilities at risk for fulfilling their needs at least at the same level as the present generation does. Notable uncertainties remained but scientific evidence has proved that man made GHG emission have an effect on the warming potential of the atmosphere.

Understanding the risk and potential impact of climate change based on the conclusions derived from the precautionary principle and targets of sustainable development the international agenda has initiated an unprecedented cooperation in environmental policy discussed in detail in the following chapters.

4.2 International Cooperation Addressing Climate Change

Climate change has gained wider and wider acceptance since the 19th century and consequently the international cooperation around the issue became one of the best practices of global environmental cooperation. The international efforts and agreements are on the one hand revolutionary because of their newly applied discourse in respect to the role of the human society in the observed climate change and also in their approach in providing usable messages to decision makers for planning and executing activities on the one hand combating climate change and on the other hand adapting human and economy development to the changed conditions.

The Conference on Human Environment in 1972 (**UNEP, 1972**) had an important role in igniting the international policy debate over climate change which also enabled that the Intergovernmental Panel on Climate Change (IPCC) to be formed in 1988. Climate change became one of the main agendas of the Earth Summit in 1992 on which the United Nations Framework Convention on Climate Change (UNFCCC) has been established. These have been followed by a series of actions resulting in the Kyoto Protocol in 1997 (**UN, 1998**). The Kyoto Protocol set the rules for curbing greenhouse gas emissions for the participating countries with setting binding limits. The Protocol was set to govern the climate cooperation till 2012 until which date a new agreement should have been established. By far no binding agreement has been reached by the international community addressing the post-Kyoto era, nevertheless the most important aspect of the matter is already framing that is the real effect of emission trade on the economy.

The international cooperation could only reach to its present state also thanks to two parallel developments in information technology. There has been a type of hardware and software revolution which enabled the development of detailed meteorology and climate models to investigate the process of anthropogenic emissions and their potential effects on the globe's climate conditions. Although considerable deficiencies remain as the climate is highly complex system with a list of variables, nevertheless the assessments of Fourier, Tyndall, Arrhenius, etc. can be further enhanced with making use of the advances in computer technology. Models are already capable of collecting, evaluating data and deriving global conclusions on climate deviations. Not only global but regional and local assessments may be drawn up with the help of the models which play an important role in combating climate change and also to provide solutions for regional and local adaptation strategies. From simple models to global climate and meteorology models a series of approaches has been developed and further enhanced in the last few decades thanks to the advances in IT. These modeling efforts such as the IPCC's, the EU's and other national or independent institutes have generated a wealth of tools and have derived publicly available conclusions e.g. the PRIMES and GAINS models, the 6 different models which have been used by the IPCC for the SRES study (AIM, ASF, IMAGE, MARIA, MESSAGE, MiniCam) and a series of others. Next to the modeling benefits of the IT revolution another aspect is to have an enormous impact on the understanding and presentation of the climate change phenomena that was the internet. Thanks to the information highway the accessibility of knowledge, cooperation of scientists, think-tanks, government bodies, international organizations and the debate that was accessible by the general public have induced a quantum leap in the history of climate science.

4.2.1 UNFCCC and Kyoto Protocol

In 1992, the UNFCCC has been accepted by most countries of the world on the United Nations Conference on Environment and Development, also known as Earth Summit. The Earth Summit itself was a major breakthrough in the international environmental cooperation as most of the nations of the world have been present on the summit with more than 100 heads of state in the negotiations (**UN, 1992**). This time was also 20 years after the Stockholm Conference which let two decades of scientific and economy research to mature and give on hand advice to policy makers in meeting the needs of the human civilization.

The forerunner of the summit was the Stockholm United Nations Conference on the Human Environment in 1972 which was undeniably an important step in the international environmental cooperation (**UNEP, 1972**).
The First World Climate Conference, 1979 Geneva was launched by the World Meteorological Organization with the sole focus to evaluate the climate change phenomena. Its final declaration documents that the international community saw climate as an important natural resource and without directed future actions,

anthropogenic emissions may harm the globe's climate (**WMO, 1979**). The World Climate Programme has been launched up based on the decision of the First World Climate Conference, as an international scientific program to study the phenomenon (**WMO, 2012**). The Second World Climate Conference, 1990 Geneva, was launched by the World Meteorological Organization and the United Nations Environmental Programme which has been well awaited by the scientific community. The IPCC has just issued its first assessment report in 1990 and also thanks to the World Climate Program substantially more information and data were available in the field of climate science than was in 1979. One of the major arguments against climate change was the lack of information in 1979 and although having a short decade period for research the second conference already saw an unprecedented effort of the scientific community in studying the issues of climate change. Based on the available assessments the scientific community recommended immediate action combating climate change (**WMO/UNEP, 1990**). Although the conference did not set binding targets for emission reductions, has proclaimed rules that influence the climate cooperation up to present days, such as the notion of common but differentiated responsibilities.

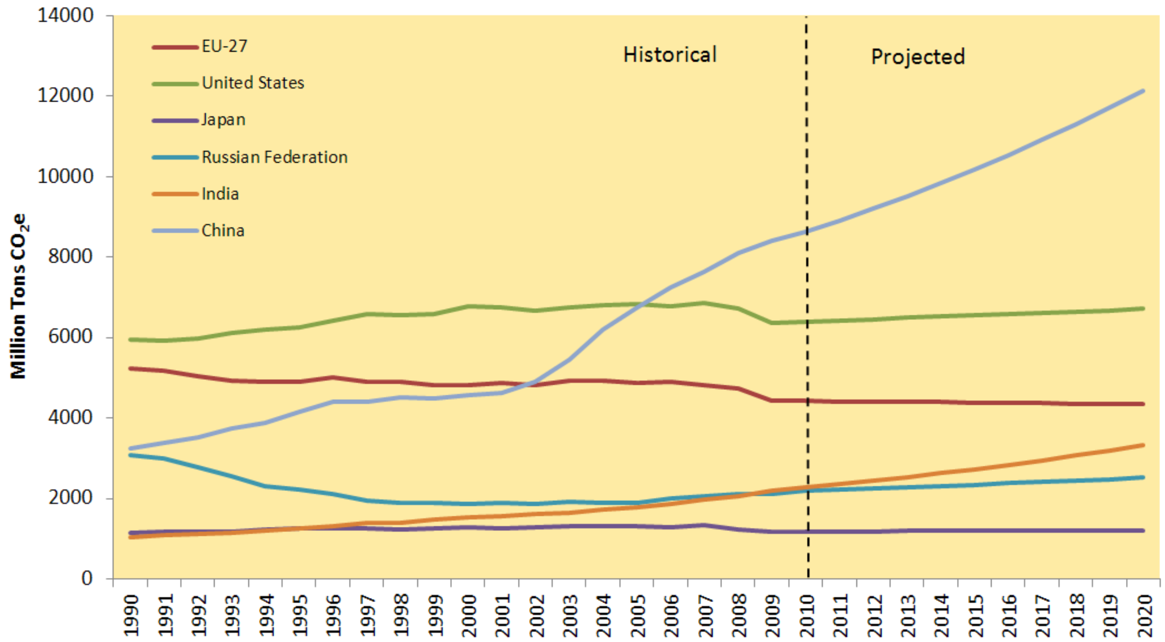
The UNFCCC provided on the one hand the basis for international cooperation addressing anthropogenic emissions affecting the climate system and on the other hand in mainstreaming the topic of climate risks. Hence, the role of the summit is irreplaceable in respect to climate policy. Meanwhile, having a huge effect on the policy agenda the UNFCCC did not bring a breakthrough in respect to concrete emission reduction actions and no binding emission reduction interventions have been started. In 1997, an addition to the UNFCCC has been initiated, namely the Kyoto Protocol. While the UNFCCC set the policy and development direction of the parties, the Protocol brought a remarkable advance in the sphere of environmental policy by prescribing emission reduction targets for the participating countries.

The Kyoto Protocol was adopted in Kyoto, Japan, 1997 and entered into force in 2005. Kyoto Protocol participating countries have taken up legally binding emission reduction targets till 2012 in contrast to the base year. The operational rules of the Protocol have been prescribed in 2001 by the so-called Marrakesh Accords" (**UNFCCC, 2001**)

The Protocol although established in 1997, did not enter into force till 2005 because of the conditions set out in Article 25 of the Protocol prescribing that at least 55 Parties to the Convention including Annex 1 (developed) countries that account for at least 55 %

of the total emissions of the Annex 1 countries in the base year (1990) have ratified or accepted it as applicable. It has been nearly eight years long effort of international negotiations, follow-up work and scientific research since the inception of the Protocol and entering into force was not realized. The international agenda saw the US stepping out from the negotiations „*We have no interest in implementing that treaty*" (**Whitman C.T. 2001**). It had been a major disillusionment for the international environmental agenda because of the fact that the US has been the biggest emitter of GHG and has been till China has overtaken its place in 2006 (**NYT, 2007**). Because of this fact the ignition of the Kyoto Protocol seemed improbable.

Figure 11: GHG emissions of major economies



Source: C2ES

The rule of 55 parties with at least 55% of the total emission represented in the base year of Annex 1 countries was not set by chance. The parties intended on the one hand to gather a type of critical mass of the parties to the Protocol which could enable a broader acceptance of the international cooperation naturally basing on the notion that if most of the countries have accepted the burden voluntarily than others will follow shortly, on the other hand if the Protocol would come into force even with accessing countries with negligible or minor share in the global emissions then the impact on global emission would be such minor which is negligible both from policy and scientific point of views. The 55/55 target, as described above, which was reasonable from a policy and strategic point of views has suspended the operation of the Protocol for more than 7 years. After the proclamation of the USA rejecting the ratification of the Protocol the only potential solution for the 55/55 rule was the accession of Russia which has eventually has happened in 2005. Base year of the Protocol has been set to 1990 mainly because of the lack of standardized reliable data of national emission prior to that date. Nevertheless, some countries have requested to set an earlier date, more specifically the ex-socialist countries which have gone through an economy transition starting from the end of the 80s. Because of the transition in their economies large share of their GHG emitting industries have been already shut down which resulted in enormous emission reductions towards the end of the century.

The breakthrough of the Protocol was two-fold. On the one hand it provided a platform for mandatory CO2 emission reduction of the parties, which was icebreaking in light of the continuous scientific debate and on the other hand it was unprecedented that the Protocol officially recognizes that the developed countries have been the major cause of GHG emissions. Because of this consensus the international arena has officially accepted interventions based on the common but differentiated responsibilities which distinguish the efforts to be fulfilled by the developed and developing countries. Based on the ratification of the Kyoto Protocol developed countries are obliged to decrease their GHG emissions till 2012 on average by 5 percent (**UN, 1998**).

Table 1: Kyoto target of Annex I countries

Country	Target (1990 - 2008/2012)
EU-15*, Bulgaria, Czech Republic, Estonia, Latvia,Liechtenstein, Lithuania, Monaco, Romania,Slovakia,Slovenia, Switzerland	-8%
Canada, Hungary, Japan, Poland	-6%
Croatia	-5%
New Zealand, Russian Federation, Ukraine	0
Norway	1%
Australia	8%
Iceland	10%

Source: unfccc.int

In the ex-social countries the political and the resulting structural changes in the economy have been followed by a drop in GHG emissions as these countries have phased out inefficient and unproductive industrial sectors and have been turned their economies into a rather service based western type economy that is less GHG emission intense. Because of this economy transition the ex-socialist countries of the CEE region have accessed to an enormous surplus in allocated emission units. This access volume of emission allowances has been amplified by the effect of modified base years set out in the Kyoto Protocol and with setting zero emission reduction targets for some of the countries.

The base year set in the Protocol is 1990 for most of the parties except for some of the CEE countries, i.e. Bulgaria - 1988, Hungary - average of 1985 to 1987, Poland -1988, Romania - 1989 and Slovenia – 1986 (**UN, 1998**) as defined by the Protocol. For example the base year of emissions for Hungary is the average of 1985-87 which is before the actual economy restructuring has been initiated and thus before closing down of energy intense heavy industries consequently the allocated emission units for Hungary are higher than it would have been in 1990. At the same time Ukraine and the Russian Federation, although having 1990 as the base year, did not set an emission target and are pursuing the emission levels of 1990 in 2012.

Table 2: Countries on track meeting Kyoto targets

Country	Status as of 2009 (against baseline)
Latvia	-185.77%
Estonia	-68.78%
Lithuania	-63.30%
Romania	-60.35%
Ukraine	-58.90%
Russian Federation	-57.16%
Bulgaria	-56.77%
Finland	-53.40%
Belarus	-47.70%
Slovakia	-43.89%
Hungary	-43.04%
Poland	-37.52%
Norway	-37.00%
Czech Republic	-34.27%

Source: unfccc.int

Based on these factors the ex-socialist countries became the biggest possessors of Assigned Amount Units (AAUs). AAU trade has been widely debated and claimed to be hot air trade meaning that there is no actual emission reduction effort behind these surpluses and these are the consequence of transition in their economies. Because of this dispute the trade of AAU has only very slowly incepted which had a major breakthrough thanks to the introduction of the system of Green Investment Schemes (GIS). The GIS provides a framework of climate change mitigation measures to be implemented in countries having AAU surpluses and to be greened out post AAU sales. Based on this framework the debated hot air can be greened out through targeted energy efficiency, renewable energy, and general sustainability type of investments.

Hungary was one of the first countries to initiate IET and was able to sell AAU to Japan, Spain and Belgium with the help of the development of a GIS (**Feiler, pers. comm.**). The actual trade activities have been started in 2008 and through a series of negotiations about 11-12 million AAUs have been sold.

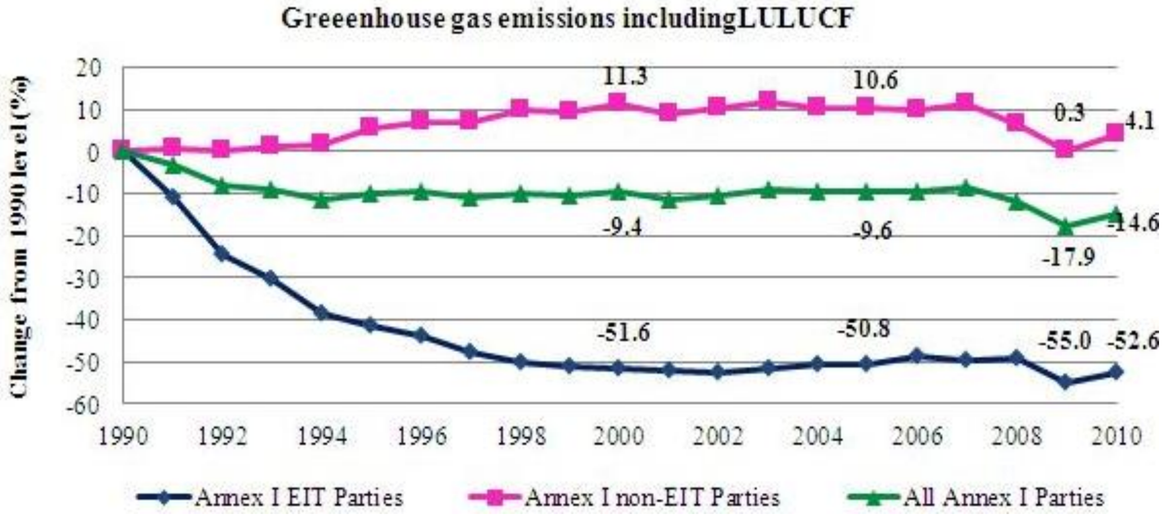
The GHG emissions of several developed countries have not decreased or have increased compared to the base year set in the Protocol.

Table 3: Countries above Kyoto targets

Country	Status as of 2009 (against baseline)	Performance
Switzerland	3.25%	!
Liechtenstein	9.05%	!
Ireland	11.00%	!
Iceland	17.21%	!
Greece	17.28%	!
Portugal	20.90%	!
New Zealand	23.05%	!
Spain	28.33%	!
Canada	29.78%	!
Australia	29.94%	!

Source: unfccc.int

Figure 12: Average fulfillment of Kyoto targets

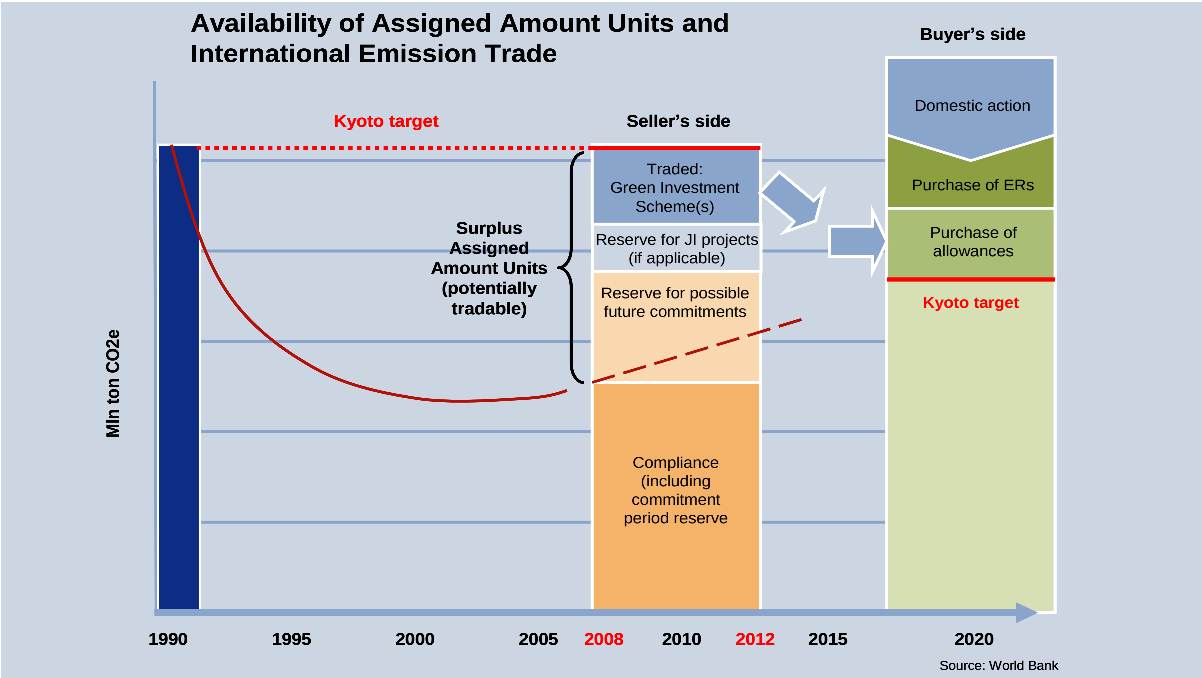


Source: UNFCCC

Those countries which are not able to decrease their emissions by their own abatement efforts are able to make use of the flexible mechanisms of the Protocol to finance reductions outside their borders in a cost effective manner. To help the cost effective emission reduction the Protocol introduced the concept of flexible mechanisms.
The flexible mechanisms of the Protocol enable three types of market based interventions into the greenhouse-gas emitting sectors which are also known as Joint Implementation (JI), Clean Development Mechanism (CDM) and International Emission Trade (IET).

From the three types of the flexible mechanisms the IET is a novel type of intervention to the emission market, hence the emission market cannot be titled as a mature one since less than a decade has passed since its inception.

Figure 13: Logic of the Protocol's country level allocation



Source: World Bank

Two project based mechanisms and one international trade based tool is available, namely JI, CDM and IET. From the three potential options the IET provides the most flexible alternative for the accounting of emission reductions. In the case of IET countries which see difficulties in meeting their targets are able to purchase AAU from those countries which have surpluses in their balances of national GHG emissions. Deficiency of the Kyoto Protocol is that although the ratification of the Protocol means a legally binding commitment of the parties nevertheless there are no precedents for penalties. Initially the Protocol did not subscribe rules for those parties which have taken on a legally binding obligation and eventually fail to achieve their targets. Conference of the Parties #7 (COP) with the so called Marrakesh Accords has established the Compliance Mechanism, the Compliance Committee (CC) and its two branches the Enforcement Branch and the Facilitative Branch which are all entitled to reviewing the compliance of the parties of the Protocol and initiate adequate measure in case of non-compliance (**UNFCCC, 2001**). There have not been any precedents for non-compliance and the state of the international negotiations questions if any penalties are to be introduced in the near future which also endangers the potential success of the global emission trade systems.

The most important aspect of the matter is already framing that is the real effect of emission trade on the economy. Making it simple, it is all about money. Decisions on paths of economy development and environment protection that have immediate direct effects on market prices and the daily spending of the population are not easy to make. The dissertation is to serve the needs of decision- and policymakers, scholars of the environmental agenda and all stakeholders of the emission market by providing a throughout study of the evolution of the concept of climate change, of the magnitude of the market and potential size when a global agreement is to be achieved and by the development of the method of a safe and sound best practice in international emission trade.

4.2.1.1 Clean Development Mechanism and Joint Implementation

The two project based mechanisms are derived ultimately from the UNFCCC and the Kyoto Protocol. The logic of implementing such projects is the following: the achievement of a carbon emission reduction project is executed in the beneficiary country where the emission reduction is more economic. Such projects can be of various types with the definitive target to achieve greenhouse gas emission reductions. The reduction must be quantifiable and based on the realized GHG emission reductions carbon emission certificates are assigned to the project. These certificates are tradable units from which additional funding can be realized in return to the quantifiable emission reductions or can be used for meeting the emission reduction targets of the company or the participating country. Both project types have a rather complicated administration procedure. The JI type projects have two sub types, namely Track I and Track II. In the pile of project based interventions the JI Track I has the simplest administration procedure and the JI Track II is very similar to the more complicated CDM procedures.

Table 4: Eligibility requirements for the Protocol's project based mechanisms

<table>
<tr><th></th><th>JI Track I</th><th>JI Track II</th><th>CDM</th></tr>
<tr><td rowspan="7">Participation requirements to be met by host country</td><td colspan="3">Party to the Kyoto Protocol</td></tr>
<tr><td colspan="3">Designated National Authority (CDM)/Designated Focal Point (JI)</td></tr>
<tr><td colspan="2"></td><td>Compliance with sustainable development goals</td></tr>
<tr><td colspan="2">Calculation of Assigned Amount</td><td></td></tr>
<tr><td>National system for estimation of anthropogenic emissions and removals by sinks</td><td></td><td></td></tr>
<tr><td colspan="2">National emissions registry</td><td></td></tr>
<tr><td>Submission of national GHG inventory</td><td></td><td></td></tr>
<tr><td>Validation/Verification</td><td>Validation/verification according to host country procedures</td><td colspan="2">Validation/verification by Independent Entity/Supervisory Committee</td></tr>
<tr><td>Transfer of ERUs/CERs</td><td>Issues of ERU according to host country procedures</td><td colspan="2">Issue of ERU (JI)/CER (CDM) upon validation/verification by Independent Entity/Supervisory Committee</td></tr>
</table>

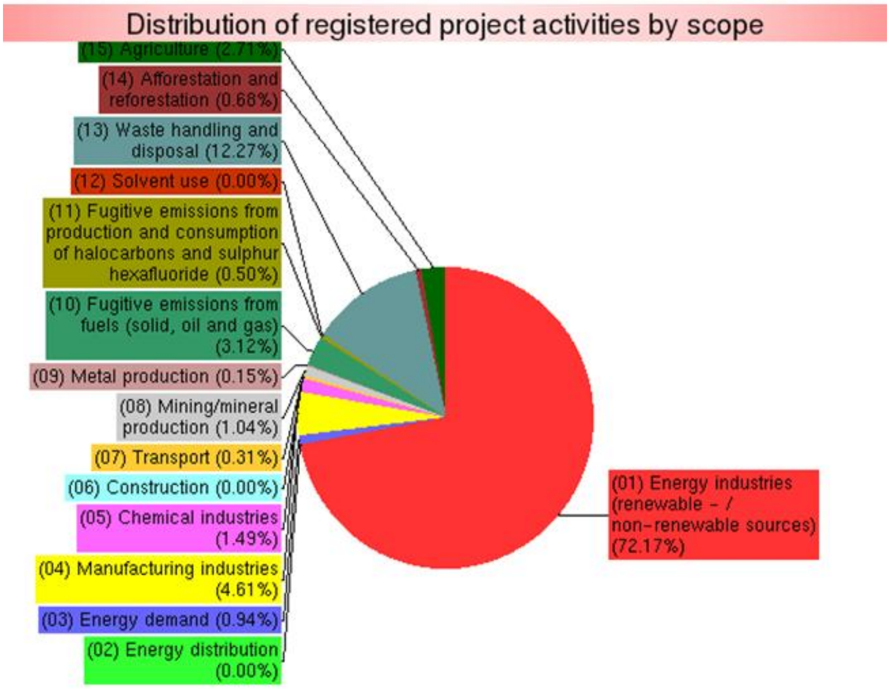
Source: unfccc.int

Both CDM and JI build upon this definitely simple logic their difference is in the targeted host countries. CDM can only be executed in developing countries meanwhile JI only in developed ones. Apart from this, the logic of the two mechanisms is the same, namely the achievement of cost effective emission reduction projects. Based on the local potentials certain projects can generate higher emission reductions on a lower cost than it could be in the home country of the investor, thus the interest for such project based investments has been very high.

In the case of CDM, as of 23.11.2012 there have been 5128 registered projects and a total of about 1 billion CERs have been issued. In the case of JI, 484 Track I and 48 Track II projects have been registered as of 23.11.2012. A total of 88 projects have been through final verification out of which 55 hosted by Ukraine (**UNFCCC, 2012**). The same applies to CDM and JI projects that most of them focused on the energy sector development.

Table 5: Breakdown of project based mechanisms by scope of interventions

Sectoral Scope	Registered Projects
(01) Energy industries (renewable - / non-renewable sources)	4228
(02) Energy distribution	0
(03) Energy demand	55
(04) Manufacturing industries	270
(05) Chemical industries	87
(06) Construction	0
(07) Transport	18
(08) Mining/mineral production	61
(09) Metal production	9
(10) Fugitive emissions from fuels (solid, oil and gas)	183
(11) Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride	29
(12) Solvent use	0
(13) Waste handling and disposal	719
(14) Afforestation and reforestation	40
(15) Agriculture	159



Source: unfccc.int

As seen above, the majority of the projects are related to the energy sector having good savings potentials in general. Hence one would expect the energy sector have generated the biggest GHG reductions under the Kyoto Protocol's project based mechanisms. It was not the case that is to be thoroughly analyzed under the defects of emission trading regimes.

4.2.2 European Union Emission Trading Scheme (EU ETS)

Parallel to the inception of the Kyoto Protocol the European Union has launched up a new mechanism in the field of climate change and environmental protection, namely the European Union Greenhouse Gas Emission Trading Scheme (EU ETS). Beginning of 2005 the EU ETS started its operation. It was and is presently the largest multinational platform of environmental protection which draws on the rules of market wisdom in the environmental protection arena for curbing greenhouse gas emissions of the biggest GHG emitting industries of the Union (**EC, 2003**). Directive 2004/101/EC also called as Linking Directive established the frame for connecting the EU ETS to the Kyoto Protocol that made it possible to utilize the emission reductions achieved through the Kyoto Protocol's project based mechanism in the ETS. The European Union's intention with establishing the EU ETS was to create a market based platform for industries to curb their emissions parallel to setting emission limitations.

The ETS regulates around 11.000 energy intensive installations in the EU-27 and the EEA-EFTA countries including Iceland, Liechtenstein, Norway and Croatia accounting to a 31 country system (**EC, 2013**). The ETS stands for close to half of the countries' carbon dioxide emissions. These installations include power, and other combustion plants, refineries, coke ovens, iron and steel plants, aluminum, petrochemicals, and ammonia producing sectors and also cement, glass, lime, brick, ceramics, pulp and paper industries. The 3rd trading period of the EU ETS also involves N2O and perfluorocarbons as greenhouse gases for reporting and compliance (**EC, 2003**).

The approach of the ETS is revolutionary because of its market based logic which compared to other emission limitations not only set a rule for emission reductions but provides a market based tool for businesses to meet these limitations through various strategies. This system is also known as cap and trade. The cap has been ultimately set by the EU Commission based on the Kyoto Protocol's targets, and based on which national governments have set the national sector targets, also called as National Allocation Plans (NAPs). Allowances in the ETS are traded through the Community Independent Transaction Log and it is done through a pure electronic system thus allowances are available electronically only which is also a novel type of system from a financial market perspective. In this framework each participant has various options to meet its reduction target in the most cost effective manner. The ultimate philosophy of emission trading is that because of the market based logic the market actors themselves are implementing cost effective emission reductions resulting in the least cost approach in GHG emission mitigation.

The ultimate goal of the ETS is to support the achievement of the Kyoto Protocol's reduction targets for each member state thus it is not a new burden to countries or industries but the market based tool of compliance targeted in the Kyoto Protocol.

The EU ETS has gone through a major reform in the end of the years of 2000 and the Community has established the grounds for the 3rd trading period of the ETS with the modifications of the Directive 2003/87/EC (**EC, 2009**).

The major changes affect allocation rules, freely available quotas, and auctioning rules. Experiences of Phase I and Phase II of the EU ETS determine the foundations of Phase III (**EC, 2011**).

In Phase I.:

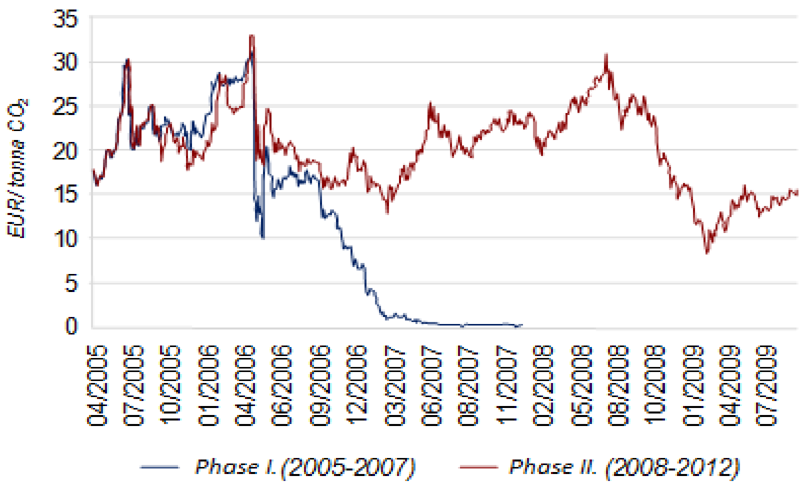
- Participants applied for quotas based on their historical emissions
- Requirements of the new entrants were satisfied
- Governments tried to enhance the competitiveness of their industries during allocation. (**Luttmer, pers. comm.**)

These rules resulted in over allocation and the price of the quotas collapsed in 2007.

In Phase II:

- Prices remained relatively stable due to the decreased number of freely allocated quotas

Figure 14: Carbon price collapse at the end of the 1st trading period

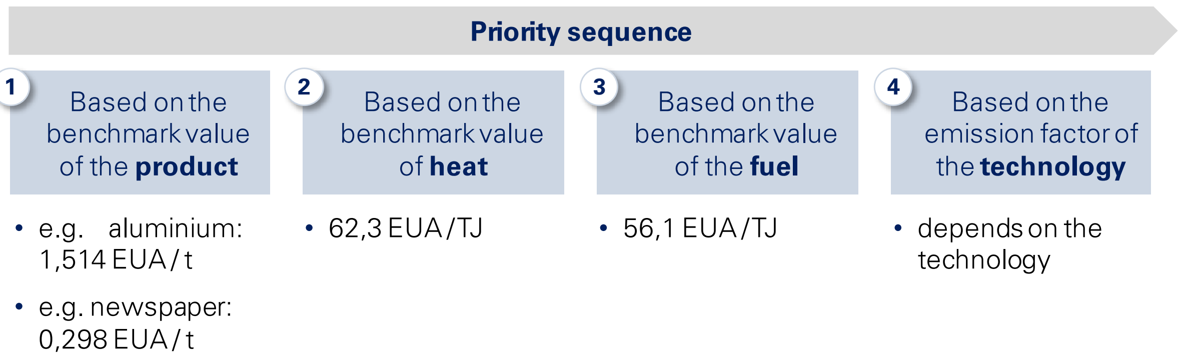


Source: ECX

In Phase III:

- The allocation method of free quotas and eligibility are revised
- Free quotas are based on EU wide benchmarks
- Concerning the reference values, the Commission had taken into consideration the performance of the top 10% most efficient installations from 2007-2008 (Best available techniques-BAT)
- Remaining quotas will be auctioned (part of the national budget)
- 50% of the revenues from the auctions have to be spent on sustainability issues (**EC, 2011**)

Possible allocation methods in priority sequence:

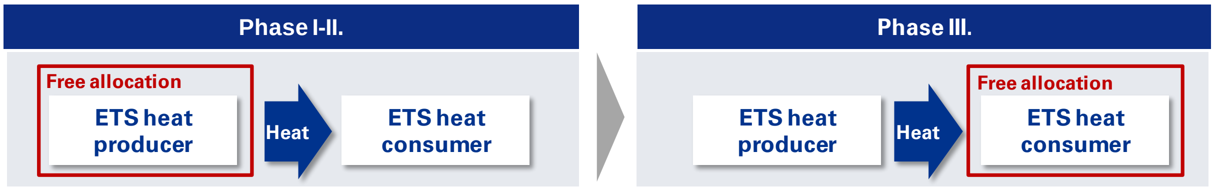


Consequently, the number of free allowances is independent from:

- Historical emissions
- Production technology
- Method of heat production
- Type of fuel (**Herczeg, pers. comm.**)

The benchmarking methodology brought the deepest reform to the system since its inception which might diminish the level over allocation experienced in the National Allocation Plans of most of the participating countries. This shall provide the main tool to overcome the problems of over allocation that is analyzed in detail in the following chapters.

Phase III involves heat consumers to the emission trading:



The EC claimed that the earlier method has not triggered enough investments into energy efficiency measures in the heat production and consumption sectors because the CO2 related burdens were presented as costs that could not be influenced by the heat consumers. Based on the modified system the heat consumer gets free allowances and thus its position gets strengthened:

- 'the right to emit' as an asset on the consumers' side
- efficiency of the heat producer will be visible to the heat consumer.

Based on the above, 3rd phase of the EU ETS has changed the status quo of the emission trading system by decreasing the amount of freely allocated quotas. As consequence the covered entities will experience increasing exposure to the price volatility of quotas. The EU's ultimate target was to establish competitive edge of more efficient technologies. Based on the above the EU is on the way of handling the problems of over allocation in the 3rd phase of the ETS with which it may give solution to one of the main defects of the present emission trading regime. The issue is discussed in detail in the following chapters of the dissertation.
Resultantly, there are more triggers deployed in the 3rd phase of the ETS which drive GHG emitting industries in the field of technology and energy industry investments to:

1. Improve production efficiency (lower GHG emissions per product)
2. Improve GHG intensity (switch from coal firing to gas firing)
3. Utilization of renewable energy sources (e.g. biogas from waste).

The problems were critical to the success of the system, hence the changes implemented by the EC were inevitable. Nevertheless, deeper interventions might be necessary to revitalize the emission trading system in the 3rd phase of the EU ETS.

4.3 Logic of Multinational Emission Trading Regimes

For providing clear understanding of the mechanisms of the global emission trade systems the below table summarizes the definitions which provide the starting point for establishing an understanding of the complexity of the issues of climate cooperation on the global level.

Table 6: Definitions in emission trading systems

Abbreviation	**Definition**
EU ETS	European Union Emission Trading Scheme
EUA	European Union Allowance: Equivalent of 1 metric ton CO2 emission under the EU ETS
AAU	Assigned Amount Unit: Equivalent of 1 metric ton CO2 emission under the United Nations system or the Kyoto Protocol
EUA = AAU	The two units are identical in form of describing 1 metric ton of CO2 equivalent but AAUs are used only by parties to the Kyoto Protocol (countries) and EUAs by companies covered by the EU ETS
IET	International Emission Trade
NAP	National Allocation Plan: countries participating in the EU ETS need to develop NAPs for planning their free allocation of allowances
JI	Joint Implementation: project based mechanism in developed countries under the framework of the Kyoto Protocol
CDM	Clean Development Mechanism: project based mechanism in developing countries under the framework of the Kyoto Protocol
ERU	Emission Reduction Unit: Equivalent of 1 metric ton CO2 emission generated through JI projects
CER	Certified Emission Reduction: Equivalent of 1 metric ton CO2 emission generated through CDM projects
RMU	Removal Unit: Equivalent of 1 metric ton CO2emission generated through land use change projects under the Kyoto Protocol
VER	Voluntary Emission Reduction: Equivalent of 1 metric ton CO2emission generated through voluntary projects out of the scope of any international treaty.

(**Feiler, Luttmer, Herczeg pers. comm.**)

The prerequisite of emission trade is to connect one ton of carbon dioxide emission equivalent to any type of greenhouse gas emitting activities. As a next step emission reduction targets or caps are defined that prescribes the covered entities to mitigate their GHG emissions. In the case of any process or fuel and conversion efficiency the concrete emissions can be identified based on simple multiplications. Countries under the Kyoto Protocol and companies under the EU ETS are obliged to keep track of their emissions, report it to different authorities and ultimately meet their caps. Although the two emission trading regimes have been established parallel did not create full compatibility in trading activities.

The EU ETS targeted to commercialize the implementation of the Kyoto Protocol within the boundaries of the EU. The ultimate goal of the ETS is to help the achievement of the community's Kyoto targets. Hence, the ETS covers big emitters such as industries and the energy sector whose contribution is relatively high to the national emissions. Emission trade is articulated to be the best option yet to commercialize the emission reduction market. Companies having a cap on their emissions are motivated to find ways which both serve the needs of environmental protection and business efficiency. In this way, companies look at their cost structures and create strategies to rationalize them. The philosophy of the system is supporting the ultimate economy goal of the EU with increasing competitiveness. This approach on the company level may entail operational efficiency improvements, investment/divestment transactions, or geographic translocation of activities. The power generation sector is limited in the case of the latter, meaning that it is limited in relocation and resultantly the issues around regional fuel price differences and a standard CO2 burden arises to be discussed in detail under the defects of emission trade.

In the years 2005-2007 the two systems did not allow for cooperation of Kyoto and ETS projects thus the use of Kyoto units were possible on the international country level. Presently, the most liquid tradable units are under the scope of the EU ETS, namely EUAs. From 2008, based on the Linking Directive (**EC, 2004**), the units generated under CDM and JI projects in the framework of the Kyoto Protocol are already usable in the EU ETS (**Feiler, pers. comm.**). The rules for using these are set in the above mentioned directive but the magnitude for using these allowances is maximized in each participating countries' respective National Allocation Plans, nevertheless it is set in most countries to 10 %. Based on this there is interest for trading with CERs and also with ERUs, nevertheless their limitations at 10 % projects a much narrower demand for such type of products.

Another factor affecting each product is their liquidity, in case of low liquidity the performance of the organized markets cannot be fruitful because competition will not be realized and none knows if any bids or offers will be accepted or not. Liquidity of the CERs and ERUs are much lower than of EUAs. CERs are traded on some of the organized platforms, hence a clear price level is published but ERUs are not traded because of their low liquidity and thus there are no clear price levels published for the JI projects.

The emission allowances are tradable goods and their trading mechanisms are very similar to other products or derivatives. They can be traded on organized markets similarly to fuels, metals on commodity exchanges or company shares, financial products on financial exchanges.

4.4 Organized platforms or exchange markets

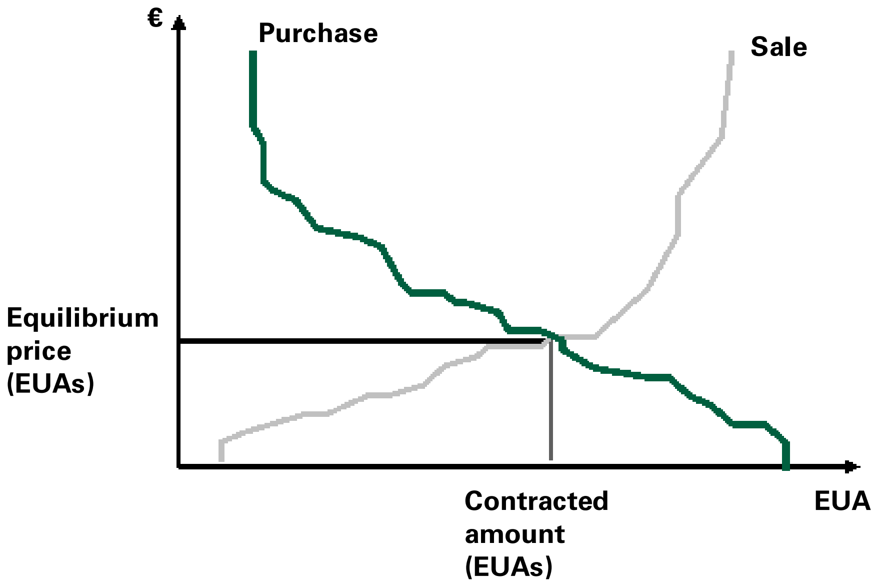
There are several organized platforms for trading with emission allowances such as the European Climate Exchange (acquired by the IntercontinentalExchange) (**ICE, 2012**), European Energy Exchange (**EEX, 2012**), Energy Exchange Austria, Nordpool (acquired by the NASDAQ OMX Commodities Europe), Bluenext (owned by NYSE Euronext and Caisse des Depots), or the Commodity Exchange Bratislava. Based on the aforementioned acquisitions the market itself is volatile and thus some of the providers of market platform could not realize the profit they expected in relation to CO2 trading.

Trading on these platforms is very similar to the mechanisms to any other exchanges:

- seller puts its offer on the market and buyers are able to bid for those;
- each buyer is able to select the ranges of price steps for the purchase of a product;
- participants who submit price dependent bids accept that the system makes a linear interpolation of volumes between each adjacent pair of submitted price steps. (**Baranyay, pers. comm.**)

A simple example is that a buyer offers for purchasing 1000 EUAs at 6.5 EUR/EUA, 100 EUAs at 7 EUR/EUA and 0 EUAs above the price of 7 EUR/EUA. The seller is able also to set price steps in a very similar way. In case the seller sets 7.5 EUR/EUA as the minimum price there will not be any exchange realized between these parties. If the seller has set a price range between 6-7 EUR/EUA then this exchange can be executed. If there is no other offer and no other bid than the total 1000 EUAs will be sold at 6.5 EUR resulting in 65 000 EUR worth deal. This is rather a rare case that no other sellers and no other bidders take any other positions thus usually the price is set in a more competitive manner. It means all the sales and all the bids are put in a basket. As soon as the deadline for participants to submit bids has passed, all purchase and sell orders are aggregated into two curves for each delivery; an aggregate demand curve and an aggregate supply curve.

Figure 15: Example of price formation on exchange markets



Source: Own figure illustrating commodity exchange market methodologies

In case of the above example in a competitive situation a potential outcome would be that the seller is able to sell its entire 1000 EUAs. Its generated income would be between 6,5 and 7 EUR/EUAs, for the sake of an example let's say 6.83 EUR/EUAs thus resulting in a total trade volume of 68 300 EUR. Based on the example the price did not reach 7 EUR/EUAs thus the total amount could have been purchased but if the price reached 7 than the buyer would have accept only 100 EUAs and thus its purchases would equal to 7 000 EUR total. The peculiarity of trading on organized markets is that the trading participants are in contractual relationship only with the organized market and thus the actual entity of the seller or buyer is not disclosed to any participant.

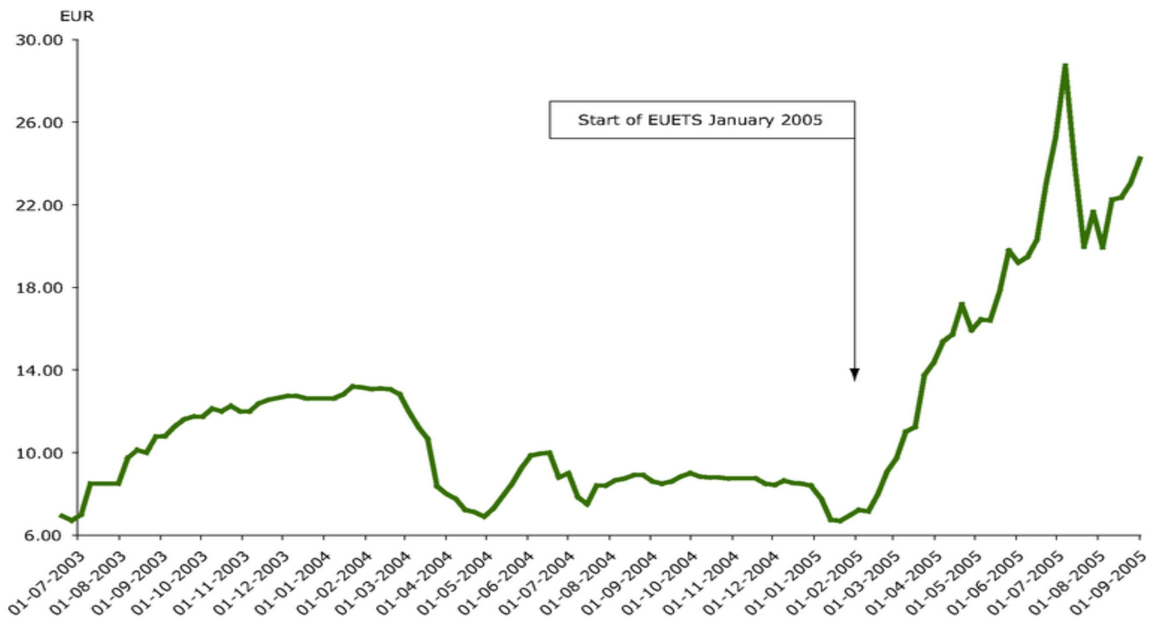
4.5 Bilateral trading activities

The other options for trading with emission allowances are the bilateral contracts. Bilateral agreements can be established through direct channels between trading participants or through the so-called over-the-counter (OTC) market (**Baranyay, pers. comm.**). As any other goods the emission allowances can be exchanged between any parties holding an emission allowance account in any country's emission registry. Simple to say, if I know someone who pays that level what I wanted to receive we are able to negotiate this deal and transfer the purchased emission allowances in return of the realized payment. A more sophisticated approach is to rely on the infrastructure of the organized markets but without stepping into that in terms of trading. Several trading houses have very similar trading platforms to those of the exchange markets but what they offer is an agent type of service. They connect sellers with buyers through their own electronic platforms. In case of trading through the OTC market the actual name of the seller or buyer is disclosed to the other entity at the time of the acceptance of the bid. One of the most important operators of OTC emission market is based in Budapest, Vertis Environmental Finance.

4.6 Tendencies in prices and markets

Launch up of the trading activities roots back to 2003. It was although before the actual launch up of the EU ETS in 01.01.2005. OTC trading has been initiated by several trading houses with the emission allowances.

Figure 16: Prices of emission quotas at the launch up of the EU ETS



Source: EEA

It can be seen that after the official launch up of the ETS a bullish tendency has been experienced until the publication of the 2005 verified emissions in May 2006.

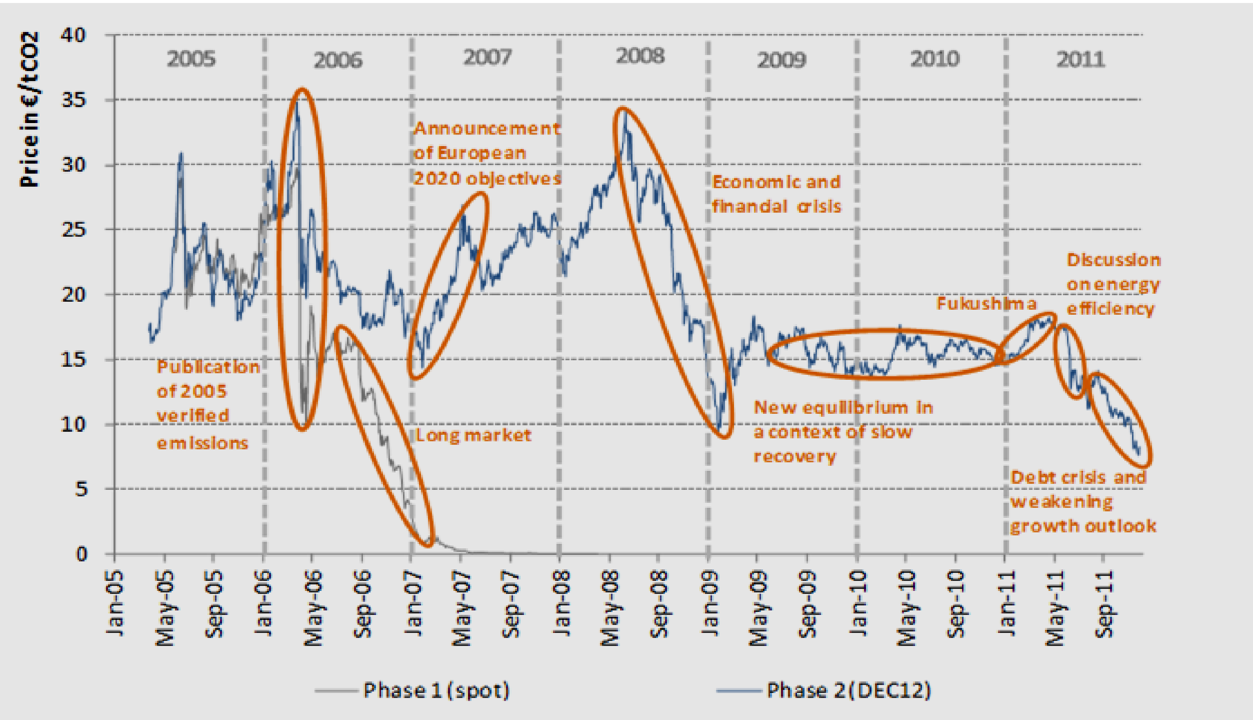
4.7 Price setting

Setting the price of carbon is of crucial importance for entities covered by the system. There are various methodologies applying to price setting. Each covered entity has its own technologies and inputs, such as fuels or material which have their particular emission factors. That means each participant of the system have the option to substitute its carbon emitting technologies with a carbon neutral one. The cost for this investment interpolated on its operational lifetime describes the substitution cost of CO2. For each covered entity the first step in its carbon sector activities should be to define the potential substitution cost of CO2. This must be the maximum that the company would pay for purchasing emission allowances on the market. If the prices went above this level the company based on pure cost efficiency logic has to go for the modernization investment to avoid carbon emissions and thus eliminate its cost on emission allowance purchases.

The picture becomes a bit more complicated in relation to the Linking Directive and the resulting possibility to use CERs or ERUs for around 10-20 % of ETS compliance. These products are priced differently than of EUAs and have a lower price range (**Feiler, pers. comm.**). The most liquid market as mentioned before is the EU ETS trading with the EUAs and partly the CER market. When deciding for an investment one should look at both markets and normalize the total costs in respect to the price level of both products. As discussed earlier the market is an immature one and thus the prices show considerable volatility. Because of the historical price fluctuations the decision for CO2 substitution projects is a hard one and thus most focused on market based compliance.

Another important factor for avoiding early investments was the case of free allocation. Most of the companies received their emission allowances freely based on the domestic National Allocation Plans and thus did not need to purchase additional units on the market. Presumably the EU decision-makers' logic was with this approach to create an operational system as soon as possible and delay the real cost effects to the 3rd period of the EU ETS (2013-2020).

Figure 17: Carbon price history (2005-2011)



Source: ECX

The free allocation helped the participants to get used to the new system from an administration point of view and face the real cost burden in a later stage when the system itself is already known to them. This approach was partly successful as the covered entities already know the system and it operated already for about a decade without any major discrepancies. But this approach was partly unsuccessful as it can be also seen on the above price graph, the prices have broken down in the case of Phase I (long market) and also shows a bearish tendency since 2010.

Since the end of 2011 the price sidled around 5-8 EUR/EUA but has reached to record low of 2,63 EUR/EUA in April 2013 (**Baranyay, pers. comm.**). The reason for the Phase I and also for the Phase II weak performance is primarily related to the free allocation and secondary to the weak performance of the EU ETS economies.

4.8 Regulation affecting the price levels of emission allowances

It can be seen that policy & regulation highly affect the performance of carbon emitting industries. The EU as a starting point, based on the UN's Kyoto Protocol, has put a cost burden on industries in relation to their GHG emissions. With the introduction of the cap and trade system the EU has not decided for a concrete cost burden but instead has set a maximum amount of emissions and expected that the market will price the emission allowances based on pure market conditions and ultimately derived from the supply-demand equilibrium of emission allowances.

The cap and trade system provided the regulatory basis for the emission trading regime, nevertheless policy & regulation has broader influence on the market and is able to influence indirectly the actual price levels of emission allowances.

A paramount step with which the regulator had intervened into the price levels was the decision for linking the Kyoto and the EU ETS through the Linking Directive. With this it provided the space to make use of CERs and ERUs generated under the Kyoto Protocol's project based mechanisms. Resultantly, increased oversupply was generated on the EU ETS market (**Feiler, pers. comm.**). This ultimately had the effect in diminishing potential price increases in the EU ETS. Further to that, the use of CERs and ERUs in the EU ETS compliance resulted in another effects on the EU ETS entities, on the one hand, the ETS entities now have the chance for arbitrage, and on the other hand the regulator has saved the market of the Kyoto's project based mechanisms. If the Linking Directive did not open the market then the Clean Development Mechanism and Joint Implementation generated emission reductions would not have any market to supply and resultantly their prices could go very fast to zero and erase the business logic behind these projects. The directive thus had two way effects, has saved the Kyoto Protocol but parallel has broken down the ETS prices. Further to this the arbitrage option for ETS participants can be considered a partly unfair practice that neglects the environmental sphere and provides the option for windfall profits to some of the ETS related traders and participants of the system. Detailed description of the arbitrage option is provided under the section of fraudulent activities in emission trade.

One of the stranded proposals of the European Commission was to delay the planned auctions of emission quotas in the period of 2013-2015, also known as backloading. The expectation was that this intervention could give a burst to the weak CO2 market. 16th April 2013 the EU Parliament has rejected this proposal and resultantly the price of EUAs has dropped to record lows at 2,63 EUR/EUA (**Vertis, 2013**).

4.9 Elimination of Free Quota Allocation to the Power Sector in Phase III of the EU ETS

From 2013 onwards a series of new rules have been implemented in the EU ETS that has launched up its third trading period or 3rd phase of the ETS 2013-2020. One of the main differences in the new period is the elimination of free quota allocation to power generators (**EC, 2009**). The Commission established the basis for derogation based on which the following countries have submitted derogation request: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania submitted applications for temporary free allocation. Malta and Latvia were also eligible but did not submit applications.

Table 7: Number of allowances to be allocated for free to power plants by Member State and year

	2013	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*Total*
BG	13.542.000	11.607.428	9.672.857	7.738.286	5.803.714	3.869.143	1.934.571	0	54.167.999
CY	2.519.077	2.195.195	1.907.301	1.583.420	1.259.538	935.657	575.789	0	10.975.977
CZ	26.916.667	23.071.429	19.226.191	15.380.953	11.535.714	7.690.476	3.845.238	0	107.666.668
EE	5.288.827	4.533.280	3.777.733	3.022.187	2.266.640	1.511.093	755.547	0	21.155.307
LT	582.373	536.615	486.698	428.460	361.903	287.027	170.552	0	2.853.628
PL	77.817.376	72.258.992	66.700.608	60.030.547	52.248.809	43.355.395	32.238.627	0	404.650.354
RO	17.852.479	15.302.125	12.751.771	10.201.417	7.651.063	5.100.708	2.550.354	0	71.409.917
Total	**144.518.799**	**129.505.064**	**114.523.159**	**98.385.270**	**81.127.381**	**62.749.499**	**42.070.678**	**0**	**672.879.850**

Source: Europa Press

The assessment of the Hungarian application has finished in the beginning of 2013 and provided a partial acceptance of the derogation request (**MNO, 2013**).

There are conditions which need to be met to qualify for free allocation based on the directive (**EC, 2009**):

- installations in operation before 2008 are eligible for free allocation;
- existing or "physically initiated" installations deemed eligible for free allocations cannot at the same time be part of the national plan of new investments aimed at retrofitting and upgrading the infrastructure, clean technologies etc. required under the Directive;
- installations have to use this free allocation to fund an approved emission reduction modernization investment (**Herczeg, pers. comm.**).

4.10 New Emission Trading Regimes Online

Not only has the EU entered a new era with the beginning of the 3rd phase of the ETS. Three other emission trading regimes have been brought alive in 2013 namely, the U.S. state of California (**Air Resource Board, 2012**), Quebec in Canada (**Ministry of Environment, 2012**), and Kazakhstan (**UNFCCC, 2012**). These systems cover primarily the power generation and the manufacturing sectors. It means by 2013 nearly 600 million people, i.e. about 8,5 % of the world's population lives in economies under the scope of emissions trading regimes.

Although these systems work separately there are intentions to synchronies their operation, ultimately to establish a multinational or global emission trading regime. In this respect the analysis of defects and the effects of regional fuel price differences are paramount to establish the grounds for improvements in multinational emission trading systems.

5 DEFECTS OF MULTINATIONAL EMISSION TRADING REGIMES

The following chapters review the issues surrounding emission trading activities. Defects are defined as follows.

Definition: Defects in multinational emission trade context

Regulatory regimes and/or commercial practices in emission trade which

- **are contra productive in terms of GHG emission reduction**
- **allow the generation of financial profits without producing any GHG emission mitigation benefits to the environment**

The main defects are analyzed, investigated and financially rated in the following but beforehand two defects shall be introduced in advance that both have long lasting negative effects on the operation of emission trade systems.

Lack of dialogue of 'real' decision-makers

One of the ultimate defects of emission trade is related to the lack of dialogue and communication. This can be seen on all of the global, regional and national levels. Being more precise, meanwhile there is a continuous scientific dialogue around the issues of climate change there is a lack of dialogue on the government level where 'real' decision and policy makers would be in position to further the case of GHG emission mitigation. There is a considerable media distortion in the case of climate discussions. One could say climate issues are thoroughly discussed because of the overwhelming number of news spots and articles, nevertheless these mostly pursue to scandalize the topic and create extra viewer number and viewer ratings. Meanwhile the growing media attention the Conference of Parties cannot fulfill its role in providing real decision making platforms for the climate negotiations.

Figure 18: Number of participants in UNFCCC, Conference of Parties

Source: COP18

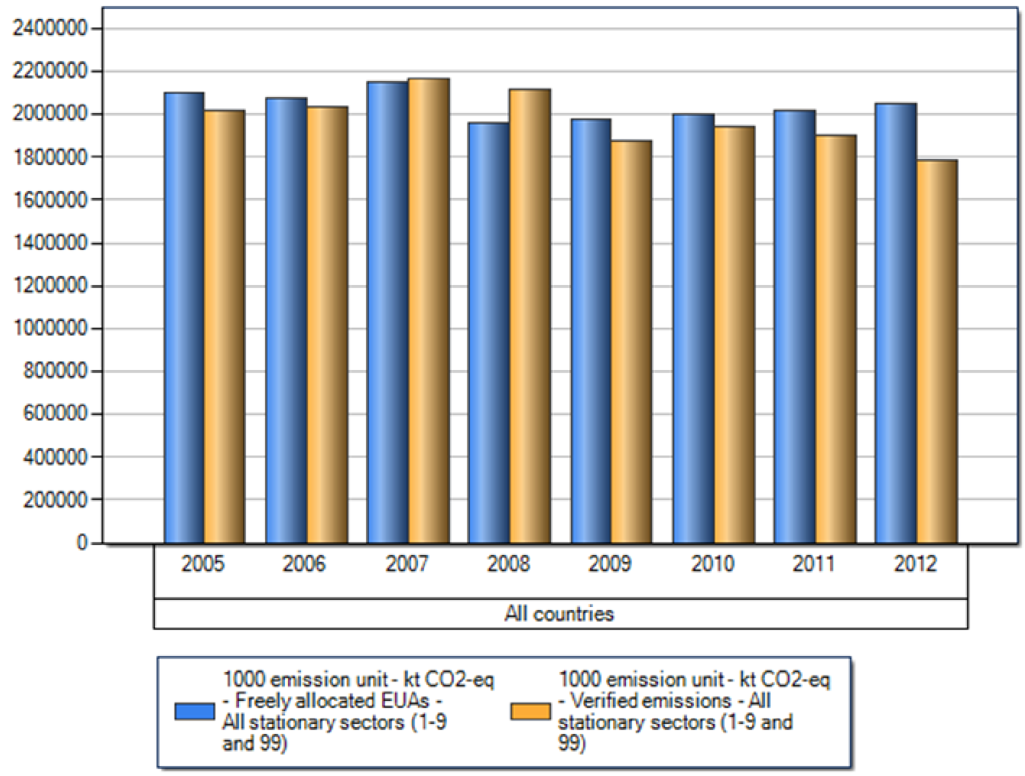
For example selecting the delegation of Hungary the highest ranking officer and head of the delegation was a deputy state secretary whose decision making capacity is surely real but negligible to prime ministers and presidents. Although the participation of higher ranking policy makers would be needed the way the climate negotiations operate make it difficult for them to take part in the process. In the case of the Kyoto Protocol and the conferences addressing the post-Kyoto era the standard annual COP conferences provide the major platform for discussion and negotiations.

Undeniably, the number of participants made it literally an impossible mission to conclude straightforward decisions on these meetings. The approach what has been put forward by the UNFCCC is fine for climate negotiations but for decisions. Real and sound conclusion may have been easier accepted in a conference series that is pursued e.g. by the G8 aka. the Group of Eight (Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom and the United States + the European Union). As the main platform for world leaders to meet annually and discuss global issues it is one of the most powerful international cooperation which primarily focuses on economy issues. Each year, G8 holds a Summit where Heads of State and Government of member countries discuss major global issues. G20 comprising of 19 countries and the EU (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States of America) provides a similar platform but already having too many participants to further sound agreements in the economy or in the climate negotiations. G8, G20 or a platform that bears a similar level of decision making capability could provide a major trigger to the climate negotiations.

Issues around over allocation

One of the ultimate defects of emission trade is undeniably the issues of over allocation. As discussed in previous chapters the over allocation of freely available quotas directly led to the price collapse of Phase I of the ETS and this could have been only avoided in Phase II resulting from the fact that the Phase II quotas are transferrable to Phase III (also called as banking). It is hard to judge on initial political motivations post hoc thus there remains only space for guessing the real reasons of such magnitude of over allocation that has been seen in Phase I-II of the ETS. Only two years have been identified in which free allocation was less then verified emission in 2007 and 2008 but the average emissions were much below the freely allocated quotas both in Phase I and Phase II of the EU ETS.

Figure 19: Freely allocated EUAs and verified emissions in the EU



Source: EEA

As for a high level assessment of the reasons behind over allocation three main arguments could be identified:

1 Phase I-II have been a try-out period in which it was not the major goal to target real emission reductions

2 The economic down turn resulted in surprisingly low real emissions in Phase II of the ETS

3 The system was meant to source hidden state aid to the productive sectors of the European Union including coal fuelled power generation.

Over allocation seems to fade away in Phase III because of the reformed allocation method (benchmarking) already discussed in the dissertation, nevertheless it provides a useful experience gained in the ETS to be made use of in the planning of any future multinational emission trading regime.

Both topics of decision making power and over allocation are inherent to the system that means the policy process is capable of overcoming them with rather simple technical regulation on modalities of the decision making process and the rules on the available freely allocated quotas thus although these are paramount in identifying the defects of operational emission trading systems they are not to be further investigated in the analysis apart from those cases where another defect can be deduced from them (e.g. over allocation is touched upon in the case of arbitrage issues).

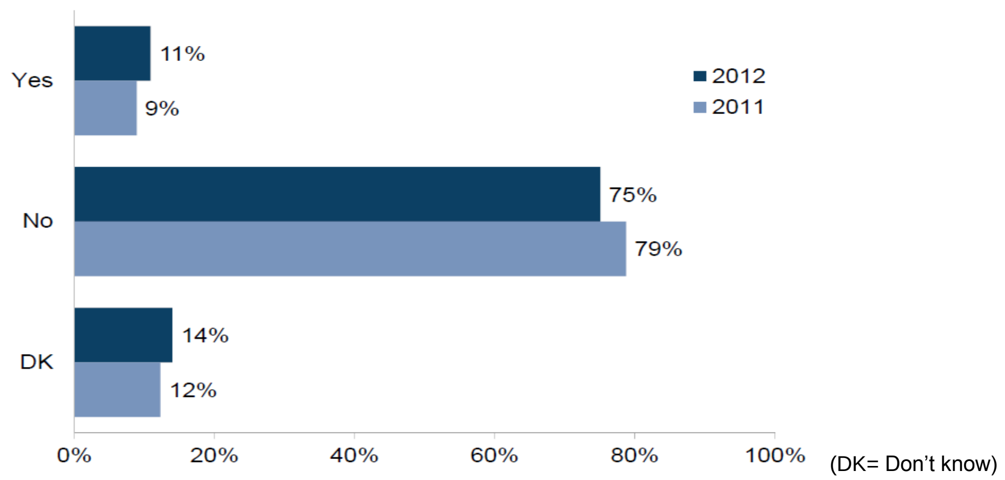
Short conclusion

Inherent defects of emission trade system, namely lack of decision making body/power and issues around over allocation are technical which can be overcome with straightforward rules and decisions of the international community

One of the major service providers in the emission trading industry issues its annual review on the state of the emission trading in which it mostly surveys the opinion of market participants.

In relation to fraudulent activities the following results have been drawn up:

Figure 20: Breakdown of answers to the question "Have you ever witnessed fraud, embezzlement, corruption or theft in connection with the EU ETS?"



Source: Heimdal et al.

The survey did not focus on the details of the fraud but requested a simple yes or no decision. Based on the answers of 2012 a slight improvement has been experienced compared to 2011 in the perception of stakeholders regarding to the fraudulent activities in the EU ETS. Based on the findings of the present analysis the magnitude of fraud is enormous and the perception of participants may be accounted to the lack of transparency in the system. The following analysis targets to quantify the magnitude of fraud based on an own developed typology of frauds.

5.1 Fraudulent activities experienced in multinational emission trade systems

The emission trade system is a rather new one as described in the literature review of the dissertation and as such had to face serious fraudulent activities in the last decade. These types of defects are considered as operational defects of emission trading. The fraudulent activities of emission trade systems are on the one hand similar to any other type of trading abuse and on the other hand some are typical only to the emission trading practices.

The first group of fraudulent activities is independent from the emissions and can relate to any trade processes especially export-import, tax or VAT fraud. This group of frauds is presented in a descriptive manner and recommendations are developed to prevent them happening. The second group of activities is related only to emission trade and can be seen as the result of immature market conditions, lack of sound policy, and regulation which could prevent trade participants to misuse their assets of carbon emission reductions for creating wind-fall profits without or with minimal deliberate emission reduction efforts.

The first group of frauds as described above does not root back only to the emission trade systems they are also experienced in other trade mechanisms.

Examples of these include:

1. missing trader or carousel fraud;
2. phishing;
3. hacking/cracking.

The second and third points are considered also as cyberthefts.

The second group of frauds relates only to emission trade, especially in multinational context. The peculiarity of them is that they cannot be proclaimed as fraudulent or criminal activities. They are derived from the options left for trade participants because of immature regulation that was not able upfront to address each process and mechanism of international emission trade. In this respect such activities are not criminal but extraordinary, creative or unconventional and have to be considered rather unfair practices:

4. double counting of emission reductions;
5. overvaluation of emission reductions and additionality problems;
6. arbitrage options.

The dissertation assesses each group of fraudulent activities in respect to their potential magnitude, experience and potential for risk mitigation through policy and regulatory interventions. The dissertation is to describe effective actions in emission trade systems to deteriorate the potential for fraud.

5.1.1 Missing trader or carousel fraud

This type of fraud is well known to customs and tax authorities. The logic is very simple and is rooted to the loose tax system of the European Community (**Europol, 2009**). In the EU the basis for free movement of goods and services is secured but there is not a common tax regime (**EEC, 1958**). Resulting from this fact the fraudsters are able to make use of the differences in tax regimes and also benefit from the lack of a central tax agency that would be able to concentrate export-import related tax issues.

In the case of the missing trader fraud the fraudster is able to use two ways of cheating:

1. buys CO2 in a country that does not have VAT imposed on emission allowances;
2. buys CO2 in a country that has the VAT system in place but exports it to another country free of VAT.

In both cases a key is that the allowances are in the hands of the fraudster free of VAT charged on them. As a next step the fraudster sells the CO2 allowances on another country's organized market and charges VAT on its sales. As it collects the purchase price and the VAT on the top of that the fraudster's company disappears without paying VAT to the national tax office. The buyers of the allowances are usually standard legal entities and mostly do not know the background of the seller. In this way the buyer's country budget is shortened with the value added tax. In several cases the innocent buyer has faced problems with its general VAT reclamations and tax offices were reluctant to disburse the tax refund on the basis of incompliance of VAT payments of the seller company which went eventually missing without paying in its VAT obligations.

A more sophisticated approach for accomplishing the missing trader fraud is when several parties are linked in a chain from which some maybe legal and some illegal entities (**Europol, 2010**). The logic behind is that the companies in the chain are buffers for the value added tax and through them to total magnitude of trade is increasing resulting in the same outcome that the VAT is not paid in to any tax authorities. Because of this chain, in which the last buyer maybe the initial seller this mechanism has been named as carousel fraud. The case of carousel fraud is much more complicated for tax authorities as the carousel can spin around 27 countries participating in the EU ETS prescribing a huge administrative issue to tackle for tax and police authorities.
It needs to be highlighted again, that the VAT fraud is not solely linked to emission trade.
There have been a series of successful attempts to stop the fraudulent activities rooted to the missing trader or carousel with which the magnitude of these practices can be elaborated on.

Tackling the VAT carousel fraud the EU established an expert group for initiating coordinated action throughout Europe. Europol, estimated the magnitude of the fraud to be around €5 billion.

Table 8: Expert group on the carousel fraud

Austria – Bundesministerium für Finanzen, Betrugsbekämpfung Abteilung
Belgium – Ministère Fédéral des Finances, OCS
Bulgaria – Ministry of Finances, Central Liaison Office / Anti-Fraud Unit
Cyprus – Ministry of Finances, Anti-Fraud Unit VAT
Czech Republic – Ministry of Finances, VAT Risk Management Team
Denmark – SKAT, Anti-fraud division
Estonia – Estonian Tax and Customs Board, Intelligence Department – International Information Exchange Division
Finland – National Board of Taxes, Tax auditing office
France – Direction Générale des Finances Publiques, Direction nationale des Enquêtes Fiscales
Greece – Ministry of Economy and Finance, VAT Directorate – Central Liaison Office
Hungary – Ministry of Finances, Anti-Fraud Unit VAT
Ireland – Revenue, Carousel Fraud Team
Latvia – State Revenue Service, Finance Police Dept.
Lithuania – State Tax Directorate under the Ministry of Finance, VAT Control division
Luxembourg – Administration de l'Enregistrement et des Domaines, Service Anti-Fraude
Malta – Ministry of Finances, VAT Dept.
Netherlands – FIOD / ECD, International Unit
Poland – Ministry of Finances, Anti-Fraud Unit VAT
Portugal – Ministry of Finances, Direcçao de Serviçios de Investigaçao da Fraude
Romania – Ministry of Finances, Central Liaison Office
Slovakia – Tax Directorate of Slovak Republic, Central liaison Office
Slovenia – Tax administration of Slovenia, General Tax Office – Central Liaison Office
Spain – Agencia Tributaria, ONIF
Sweden – Ministry of Finances, Skatteverket

Source: Eurocanet

There is an extensive list of publicized fraudulent activities which is discussed in detail below.

France: Four people have been jailed because of the carousel fraud totaling to EUR 150 million. The French tax authority assessed the total losses to the country to around EUR 1.8 billion (**Carbonfinance, 2012**). BlueNext, one of the biggest organized trading platforms of carbon emissions, was also under investigation for fraudulent activities but criminal behaviors were not proved against the company. Nevertheless, BlueNext has agreed with the tax office to settle a total of EUR 355 million tax liability (**Carbonfinance, 2012**).

Spain: Eleven people have been charged with tax fraud totaling to EUR 50 million (**Corporatewatch, 2010**).

Norway: Three people have been charged with tax fraud and money laundering totaling to EUR 43 million (**Corporatewatch, 2010**).

Czech Republic: Two men have been accused of EUR 20 million tax fraud in emission trade activities (**Prague Daily Monitor, 2012**).

UK: Three men have caused nearly EUR 60 million loss to UK's Her Majesty's Revenue and Customs Authority by setting up a carousel VAT fraud. The activities were executed between 2008 and 2009 (**Thomson Reuters, 2012**). All of the arrested have been using a company named KO Brokers Ltd to cover their criminal activities in CO_2 trade and now face a combined 35 years jail time. This was now a KO given to KO Brokers by the tax authority. Much bigger magnitude of scams has been revealed in 2011 in which police authorities cooperated with Dubai officials to crack down an international VAT fraud. The total value has been so big that HMRC was unable to cope with totaling about EUR 4 billion (**Dailyrecord, 2011**).

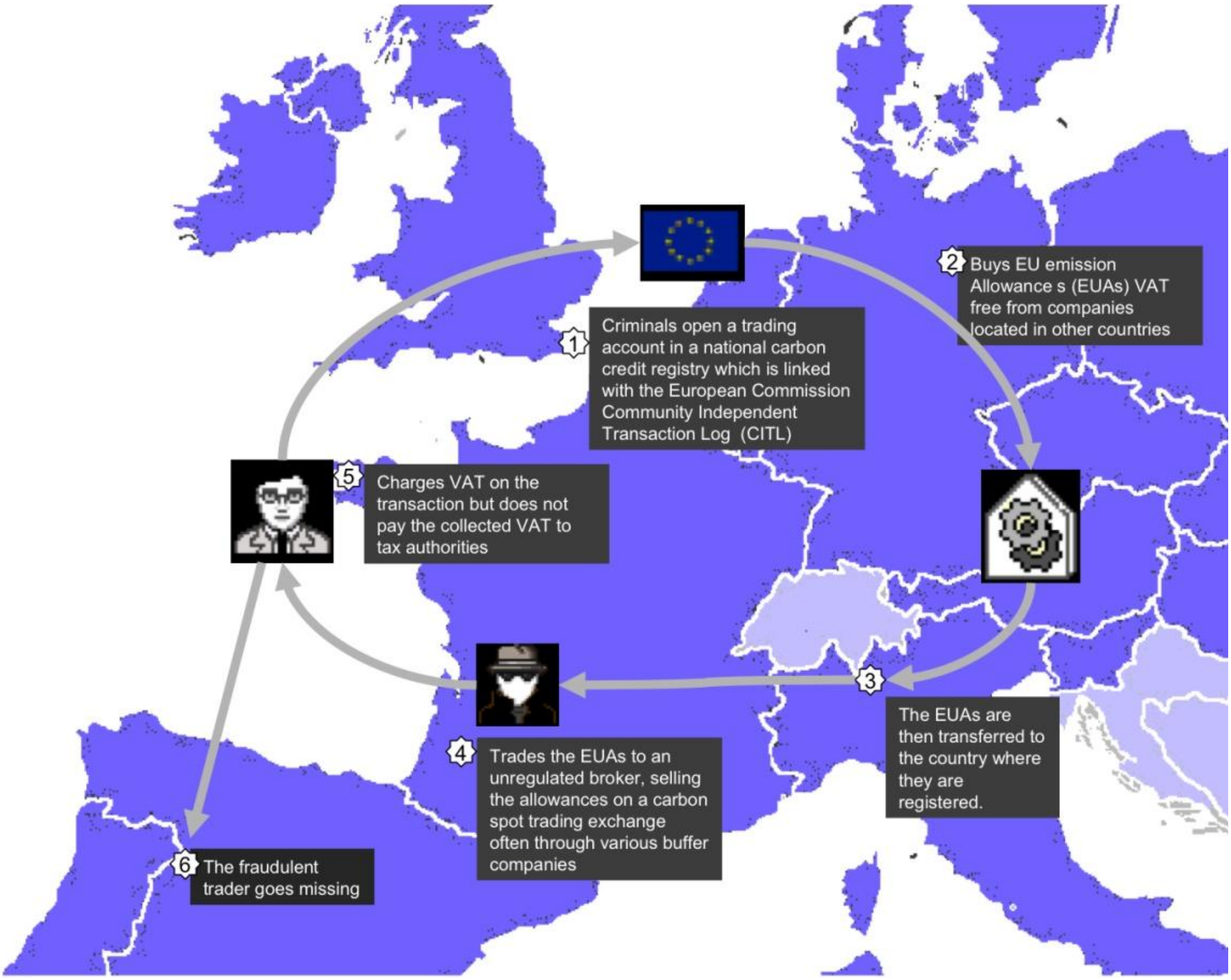
Germany: Six men have been jailed because of the carousel fraud totaling to about EUR 300 million (**Thomson Reuters, 2012**). Another 11 people have been also jailed because of the same type of tax fraud in 2011 (**Thomson Reuters, 2012**). The total amount of missing VAT can be up to EUR 850 million which involved about 50 companies and also workers of one of the most prominent German bank and also an energy company (**Spiegel, 2011**). The investigation around Deutsche Bank continued in 2012 resulting in a police raid to its headquarters and several private homes of its employees in December (**N-TV, 2012**). Following that two highest ranking officials of Deutsche Bank have been arrested by German police and criminal investigation is ongoing in relation to them.

Denmark: having one of the highest VAT levels around Europe Denmark was also affected by the carousel. No clear information is available related to the quantity of losses made for the Danish government, nevertheless more than 90 % of registry accounts have been suspended for investigations in 2010 (**Corporatewatch, 2010**).

Because of the high VAT rates Danish companies might have been used as buffers to increase the total value of the carousel (**Politiken, 2010**).

Italy: Guardia di Finanza, the Italian tax authority, also made serious attempts to identify fraudsters in the emission trade market after the Italian Power Exchange identified abnormal volumes of trading activities in the market (**Corporatewatch, 2010**).

Figure 21: Logic of the carousel fraud



Source: Europol

As it has been put by the director of Europol's director, Rob Wainwright (**Europol, 2010**):

"These criminal activities endanger the credibility of the European Union Emission Trading System and lead to the loss of significant tax revenue for governments"

Europol estimated the total losses made to EU governments to be around EUR 5 billion which based on the overwhelming amount of identified cases have been altered to EUR 7 billion by specialists (**Thomson Reuters, 2011**). Based on my own investigation and analysis around EUR 7 billion shall be even a low scenario as the latent scams may even double the total value of frauds.

The European Union understood the magnitude of the fraud and in cooperation with the Europol and national authorities continues an extensive investigation to unfold criminal activities executed in the last 6 years and deteriorate space for future frauds. The main tools in respect to curtailing VAT fraud are the introducing a reverse charge on VAT or elimination of VAT on the goods in scope. Modification of VAT rules has been supported by the EU. It has issued amendments to the VAT Directive in March 2010 based on which reverse charging of VAT is allowed till 2015. This is not a mandatory form of VAT charging but gives space for national governments to immediately modify their legislation as they think it to be necessary (**EC, 2008**).

Most of the affected member states have altered their VAT legislation to diminish the space for the carousel fraud in the carbon emission market. Nevertheless, until the tax Union is achieved the fraudsters will have a space to make use of differences in tax legislation in the member states of the European Union.

Short conclusion: future chances for MTF

Regulation was only partially successful in addressing MTF, because of the fact that there remain discrepancies in tax rules between EU member states. Some countries have no, 0 % or different percentages or have introduced reverse charging of VAT. These differences and the lack of an EU level central tax authority leaves the door open to tax fraudsters.

5.1.2 Phishing or hacking/cracking

Similarly, to the missing trader or carousel fraud the information technology related criminal activities are not solely interrelated to carbon emission trade. Through these fraudulent activities the fraudsters target to obtain user names, access codes, security information and ultimately the login passwords of IT system users.

These types of criminal activities are well known e.g. for banks. Phishing activities have been already used since the widespread of call centers and internet platforms where the clients could execute their banking activities. The fraudsters tried to obtain the login information of the telebank or the internet usernames and passwords of the account holders and execute transfers through a series of banks to an offshore bank account of their own. The key in this fraud is that the account holder gives out its security information without any violent force used by the fraudster. Instead of violent force the fraudster uses cheating to deflect the concentration of the victim or may even pretend to represent the bank itself on the grounds of which the victim readily gives out all of its security information.

An official definition of phishing based on Google is:

"A phishing website or message tries to trick you into revealing personal information by appearing to be from a legitimate source, such as a bank, social network, or even Google. If you receive a suspicious message, do not provide the information requested."

Messages or websites phishing for information might ask you to enter:

- "*Usernames and passwords*
- *Social Security numbers*
- *Bank account numbers*
- *PINs (Personal Identification Numbers)*
- *Full credit card numbers*
- *Your mother's maiden name*
- *Your birthday"* (**Google, 2012**).

There is a different approach used by hackers. In the case of hacking/cracking the fraudsters target to install malicious software on the victims' computer and follow its activities to be able to identify the targeted security information of bank accounts, credit cards, etc. These fraudsters have very similar goals to those who use cheating to obtain the security information in another ways, namely to log into the account and transfer the money to their own accounts.

On the basis of understanding the scams related to phishing and hacking, banks have introduced additional security steps, for example the SMS confirmation procedure, for each of the transactions.

In the case of national registries of emission allowances in the multinational EU ETS system there have been no set security requirements subscribed by the EU. This resulted in that each national registry had different approaches and in several cases did not subscribe a minimum level of security confirmation such as a mandatory SMS confirmation of a transaction.

The fraudsters made use of the lack of security procedures in several locations, such as Germany, Romania, the Czech Republic, Greece, and Italy. But many more countries were targeted by the phishing attack including Denmark, Poland, Estonia, New Zealand, Norway, Australia, Belgium, and the Netherlands (**NYT, 2011**).

In Romania the victim was Holcim's subsidiary, and another cement company was affected in Greece called Halyps (**Gilbertson, 2011**).

In Romania the authorities were able to prevent the sale of an additional EUR 28 million worth allowance sales connected to phishing (**Gilbertson, 2011**). Meanwhile in Italy a trader, called The Cube Energy (TCEI) has been victimized of successful phishing attack (**Thomson Reuters, 2012**). In the Czech Republic CEZ, the national vertically integrated energy company, and Backstone Global Ventures were affected totaling value of EUR 7 million (**Gilbertson, 2011**). The hackers also managed to break in the system of the registry account of Austria, establishing direct access to transactions through which losses totaled to EUR 5 million. Stolen allowances valued of at least EUR 12 million have been later on identified in the emission registries of Germany and UK stemming from the Czech, Italian and Romanian thefts (**Thomson Reuters, 2012**).

The EU decided to suspend spot emission trading to stop breaches into emission registries till new security procedures have been implemented. The suspension started 19th January 2011 and finished 20th April by reopening the last registry which implemented the required minimum security measures (**EC, 2011**).

Since that major changes have been implemented to increase the security of the registry system and a central Europen wide registry has been established and launched up 20th August 2012 (**EC, 2012**). Hence, the phishing or hacking related crimes are rendered more difficult nevertheless, the way in which the new system works became too complicated and is lacking the speed necessary for spot market activities. Spot market activities need immediate actions to be able to participate in the organized markets. A new rule of one day delay has been implemented for transactions which are executed between previously unknown parties. The only way for a faster transaction could be when the parties have introduced themselves to the emission trading system as "trusted parties". Naturally, this cannot be done in every case and resultantly delays will be experienced in the standard trading activities (**NFM, 2012**).

This modification on the one hand makes it more difficult for hackers to breach the system and on the other hand complicates the ways in which carousel fraudster may erase the traces of a series of transfers through several national registries.

Short Conclusion: Future of phishing & hacking

New rules are introduced and logic of the transaction log has been modified that renders it more difficult to fraudsters breaching to the emission trade system, nevertheless it made also difficult to execute standard transactions in the organized markets of emission trading because of overregulated and over insured new processes

5.1.3 Double counting of emission reductions (allowance recycling)

Emission allowances are goods which can be traded in a series of deals which establishes the ultimate goal of the emission trade, namely that the market has to price these commodities. In a liberal or neoliberal economist approach the market is the best positioned to assess the real value of environmental protection through setting the price of emission allowances. Trading can go on with an infinite number of exchanges until the point one surrenders those with submitting them to the national registry. At the end of each year each operator needs to submit a report on its last year's actual emissions and surrender the exact amount of its verified emissions. As soon as the operator has surrendered its emission allowances these cannot be used again in the emission trading system. The wipe-out of allowances is straightforward in the case of the EUAs used in the EU ETS. The underlying reason for erasing the used EUAs is self explanatory to avoid that one ton of emission allowance shall not be used to cover two tons of surrendered allowances with using the same one ton two times. Nevertheless there are two options which complicate this procedure and make it possible to abuse the system. One of the potential cases relates to other types of emission allowances generated through the Kyoto Protocol, namely CERs. In case a company surrendered CERs instead of EUAs under the EU ETS the logic shall be the same as in the case of EUAs, meaning these allowances have been used for covering 1 ton of emission and thus shall be wiped out of the system. The problem arose through the regulatory mistake that only prescribed to close the used CERs out of the EU ETS but not from the Kyoto trading. Resultantly, 1 emission allowance or CER could have been used by a Hungarian operator to meet its year end emission target, than the Hungarian government was rightfully selling these through a series of traders to Japan. The case would not have been revealed at all if the Japan buyers would not sell these CERs again to European traders.

Hungary has sold 2 million CERs at a price around 11-12 EUR/EUA resulting in above EUR 20 million revenues generated from reselling (**KVVM, 2010**). The case is interesting as EU ETS deals with companies and Kyoto focuses on countries. These CERs will not be accounted for meeting Kyoto targets of Hungary but were intended to be used by Japan (**VG, 2010**). In this case there is no double counting of emission reductions on the global level. Nevertheless, looking at the two parallel systems of the

ETS and Kyoto the CERs have been surrendered by Hungarian companies and later on were intended to be surrendered by Japan as a country (**KVVM, 2010**).

It has been assumed that Total Global Steel (TGS) has sold the Hungarian surrendered CERs in the ETS. But meanwhile Hungary did inform the buyers on the state of the CERs TGS never did the same selling them to Deutsche Bank worth around EUR 4 million (**Thomson Reuters, 2012**). Although the recycling of emission units has been followed by an international scandal and each stakeholder of the emission market agreed on the unfair behavior of the resellers there have not been a sound tool implemented to stop these activities. Each trading platform receives the list of surrendered emission units based on which they are able to identify the recycled CERs nevertheless market transparency shall be enhanced to secure the exclusion of these allowances from the market. But this solution applies only to the EU ETS as there is no clear message on the side of the Protocol. The reselling of CERs by EU governments may have continued and might be continuing present days.
The other way of CER recycling is through the voluntary market of emissions. The voluntary market is cheaper as there is not set emission reduction target but the companies are able to take part in it on the basis of corporate social responsibility. It has been assumed that a chemical corporation and a cement producer have used the purchased voluntary credits for reselling with higher profit in the EU ETS (**Gilbertson, 2011**).

Short conclusion: Future of double counting

The EU has introduced such regulation that terminates the recycling of used Kyoto credits in the EU ETS but there is no warranty that the credits are not recycled in countries out of the boundaries of the EU

5.1.4 Additionality problems and overvaluation of emission reductions

Prices in the emission market, as discussed earlier in detail, depend on the supply - demand equilibrium of emission allowances. More allowances are needed on the market the prices go higher or vice versa when oversupply is experienced prices fall. This gives one end of the equation meaning changes in demand may drive the prices up or down.

The other side of the equation is the supply of emission allowances. Each emission reduction project has its own peculiarities and cost structures resulting in a certain level of total costs related to one ton of emission reduction. If the costs of emission reduction would be above the market price that would imply a "no go" for the project and if they are below than the project would seem viable. The price of emission reduction ultimately prescribes the financial viability of an emission reduction intervention, hence the emission trading regime was labeled as the best tool to cut emissions through pricing each intervention through organized market platforms. Based on this logic the market is able on its own to find the best available solutions to cut cost efficiently GHG emissions of industries.

This vision requires two conditions to be met related to each project:

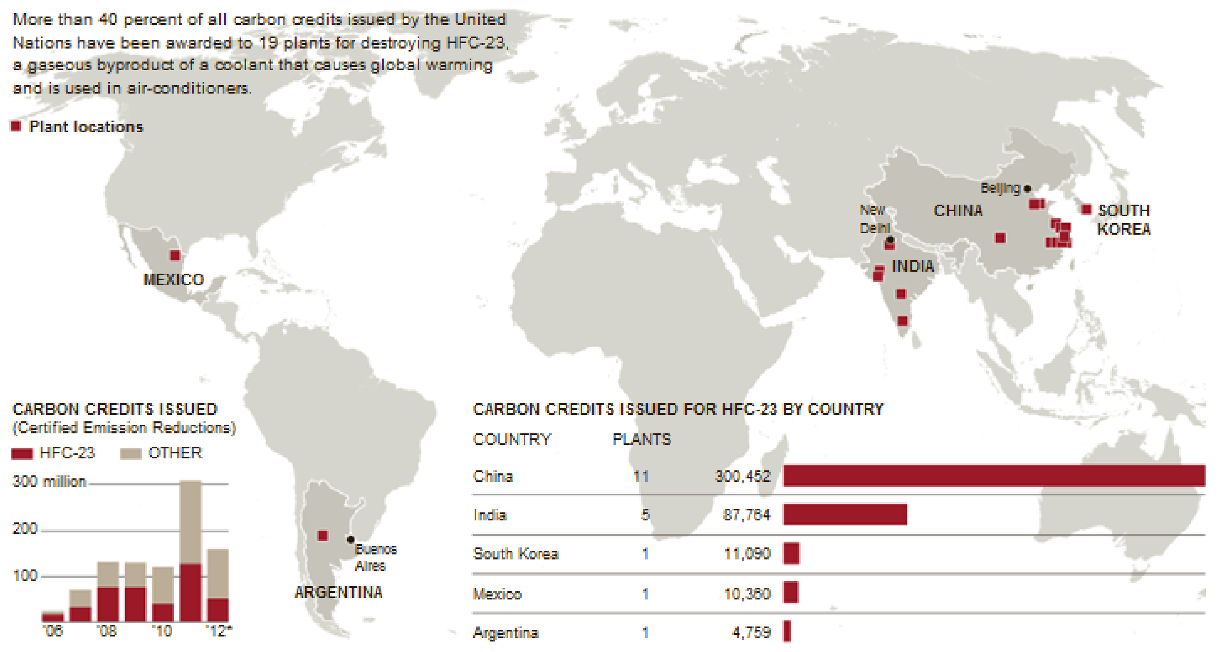
1. Any intervention needs to be additional to those which would be realized independently from any emission reduction targets (e.g. the old factory anyways needs to be shut down because of outage and a new one to be built)
2. There have to be real competition between the types of interventions to be best able to price emission reductions in a competitive manner.

There are two types of GHGs that have high warming potential, namely HFCs and N2O. There have been a series of projects under the Kyoto Protocol's Clean Development Mechanisms to cut the emissions of these gases. The process is straightforward but there have been controversies related to the actual additionality of these projects and on the valuation of the emission reductions. Based on the dispute around the controversies around these gases the EU has decided to ban the use of the allowances generated through such projects in the EU ETS from 2013. This ban applies to trifluoromethane (HFC-23), and nitrous oxide (N2O) (**EC, 2011**). HFC-23 is a by-product of the production of HCFC-22, which is used in refrigeration and air conditioning. Its lifetime in the atmosphere is about 260 years and the warming potential is particularly high about 10 thousand times higher than of carbon dioxide (**IPCC, 1995**) and thus one ton of HFC 23 emission reduction equals to about 10 thousand emission allowances (equaling to 10 000 ton of CO2). In the case of nitrous oxides the lifetime is around 120 years also having a high warming potential of about 300 times bigger than of CO2's (**IPCC, 1995**).

In respect to these two gases a perverse exploitation of the emission market has been experienced from the launch up of project based mechanisms but the lack of policy intervention let stakeholders to continue unfair exploitation of the market. The assumption is that those project owners which got into the CDM pipeline did not decrease their emissions but on the reverse to be able to gain higher profits intentionally increased the emission of such industrial gases to achieve a higher baseline figure for comparison.

Based on newspaper articles published in various issues these factories gain more on the emission market than on the production of their own products, e.g. refrigerator coolants.

Figure 22: HFC-23 projects around the world

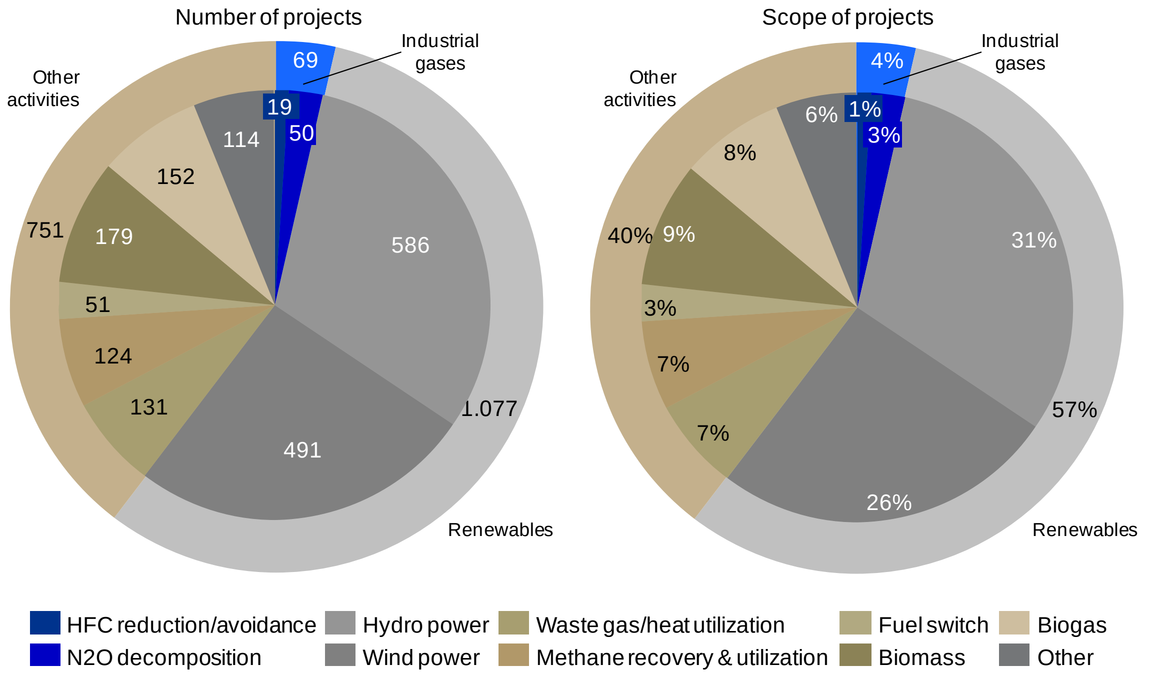


Source: NYT

Some calculations show that installing the simplest technology to capture and destroy HFC-23 in the facilities covered by the CDM would cost $100 million in contrast to the generated $4.7 billion revenues through emission trade by 2012 (**Carbontradewatch, 2012**).

HFC project although small in number (19) provide about 40 % of total generated emission reductions of CDM pipeline. This gives a huge magnitude that has been environmentally questioned since the inception of the system.

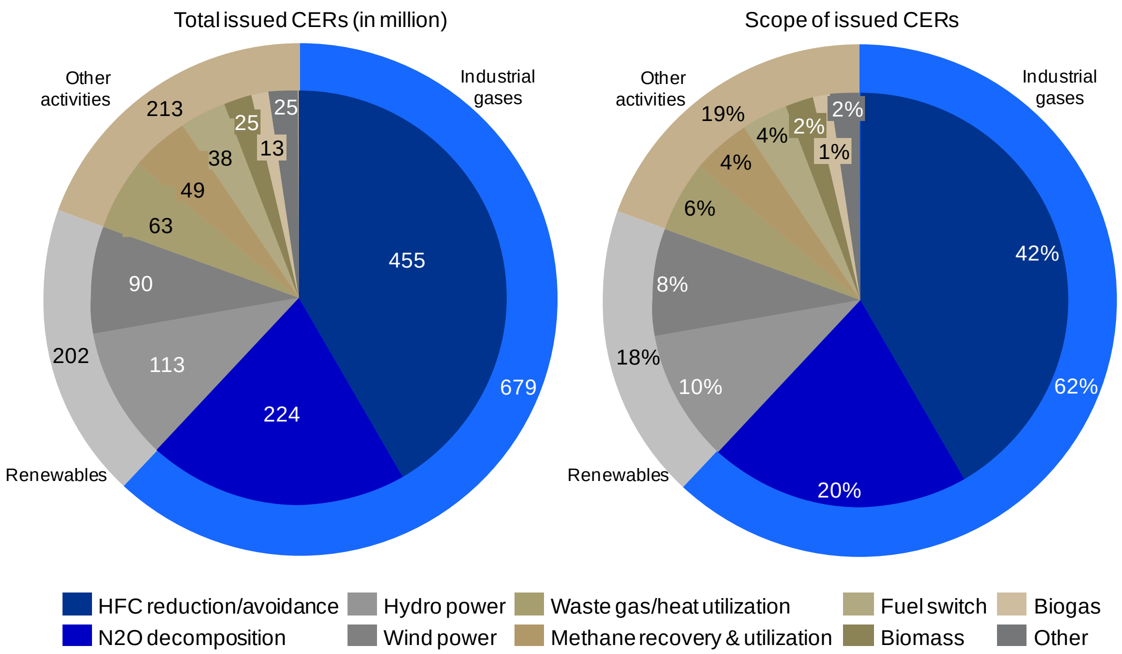
Figure 23: Number of disbursed CDM projects



Source: Own figure based on data of IGES

Unfortunately, the list of questionable projects continues with another industrial gas, namely N2O. 50 projects targeting N2O decomposition amount to about another 20 % of emission reductions of the CDM pipeline. This means that out of the ~1900 already disbursed projects about 70 or about 4 % generated more than 60 % of the total emission reductions.

Figure 24: CER issuance per scope of projects



Source: Own figure based on data of IGES

Two main topics arose that on the one hand is the pricing of the emission reductions fair and on the other hand are these projects additional to national economy paths. Some claim that the newly established HFC factories emit less HFCs without any type of carbon incomes generated than those covered by the CDM.

The exact magnitude of unfair practices with respect to industrial gas projects can be deduced in two ways. One could be assessing the actual cost of emission reduction compared to the generated revenues. As discussed above this could give around USD 5 billion. In the other way to total generated CER allowances (around 1 billion) could be investigated. If 60 % of those are not additional than 600 million allowances are blown away with taking an average price of 6-7 EUR/CER would give about EUR ~4 billion of unfair practices in the industrial gases emission market.

Other problems are also seen in the case of additionality which is not only connected to the issues of industrial gases. As discussed in detail above only those projects are to be financed through CDM which could not be realized without the inclusion into the CDM basket. That means, if a project is able to generate enough profits to be sustained on its own or e.g. there is a government decision to implement that than this projects shall be excluded from the CDM initiative.

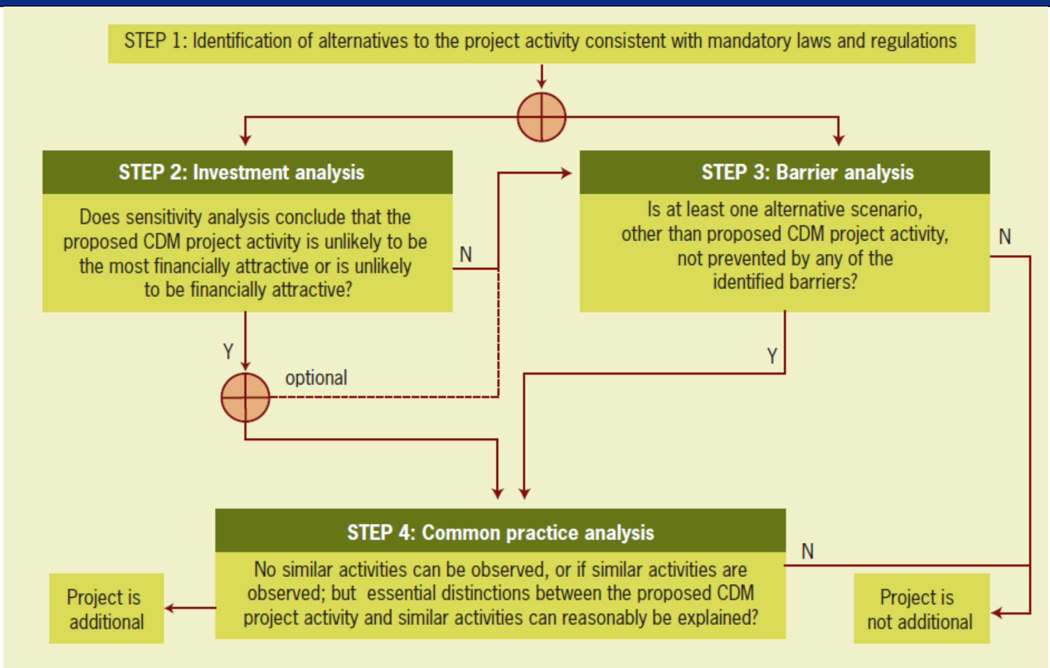
Hydro electric power project by SJVNL in Himachal Pradesh is already a registered project in the CDM pipeline although several nongovernmental organizations have raised their voices against the project. The reasons for that have been twofold:

1 Linking Directive prescribes the EU to ensure the World Commission on Dams (WCD) criteria when approving hydro projects exceeding 20 MW. Nevertheless, the Swedish Energy Agency has issued a letter of approval for the 412 MW Rampur project without applying them (**Carbonretirement, 2011**)

2 A cable published by Wikileaks highlights in detail that the Indian CDM executive board and the Indian government are targeting to avoid the questions of additionality when an Indian project is applying for CDM funding. The cable has been recorded on a Consulate meeting in Mumbai in 2008 (**Wikileaks, 2011**) and have ignited a fierce discussion around the authority of the Indian CDM Executive Board.

Yet, the project is included in the CDM pipeline and has been registered in 2011 receiving about 1,5 million CERs per year (2015-2022). The total questionable value comes to 10,5 million CERs and which equates to about 1 million EUR incomes generated at present value in the Kyoto market and about 5 million EUR if sold in the EU ETS.

Figure 25: Confirmation logic of additionality



Source: Baker & McKenzie

CEU eTD Collection

Short conclusion: future of additionality and overvaluation problems

The EU has banned such industrial gas projects of the Kyoto Protocol that had issues with additionality and overvaluation, further to that has excluded projects which do not stem from the least developed countries (LDC) nevertheless there is no clear strategy of the UNFCCC for these problems in the case of the Kyoto Protocol

5.1.5 Arbitrage options

As discussed in another chapter of the dissertation, the EU - UN cooperation decided to connect the two multinational systems, namely the UN's Kyoto Protocol and the EU's Emission Trading System. Most of the countries of the EU ETS have introduced 10-20 % allowance limit (Linking Capacity- LC) to be used for compliance derived from project based mechanisms of the Protocol such as the CDM and JI in the ETS. Because of this linkage the CERs derived from CDM projects and the ERUs derived from JI projects received a considerable demand from a liquid market such as the EU ETS. As the ETS total compliance amount was between 1.8 and 2.2 billion in the years of 2005-2012 (**EEA, 2013**), LC could give space to around 200 million project based emission reduction units per annum to be utilized in the ETS.

One could think this linkage was a logic evolution of the multinational emission trading systems and partly it was, nevertheless it had serious effects on the trading customs of the participants. In monetary terms the 200 million CERs/ERUs which have been used for EU ETS Phase II compliance can be rated in two ways:

1. One way is to assess the opportunity costs. If the ETS entity received free allowances than instead of keeping them till the reporting deadline they could make use of the so-called SWAP deals. In this way the company sold its freely received EUAs and bought instead CERs or ERUs. The price of EUAs were fluctuating throughout Phase II but for assessing the magnitude of arbitrage option an indicative 10 EUR/EUA can be used.

Freely received EUAs sold:

Sales ~ 200 million EUAs <u>at 10 EUR/EUA</u>
Total: EUR 2 billion /year
and
Purchases ~ 200 million CERs
<u>at 7.5 EUR/CER</u>
Total: EUR 1,5 billion/year
Total arbitrage: 0,5 billion/year

Based on a multiplication the SWAP option could have generated EUR 0,5 billion to ETS covered entities per annum in total for the entire EU ETS. The same multiplication in the case of the Hungarian ETS would result in a total sum of about EUR 300k per year in the period 2008-2012. For the entire period of 2008-2012 this concludes a total amount of EUR 2,5 billion arbitrage option for the EU ETS Phase II.

2. The other way of assessing the magnitude is based on the substitution cost methodology. If the entities did not have their entire emissions covered by free allocation, they could make use of the CER/ERU markets with purchasing those products instead of EUAs. This results in lower costs related to the compliance. In this case instead of buying EUAs for an average 10 EUR/EUA they could purchase 7.5 EUR/CER.

CERs/ERUs purchased instead of EUAs:

Purchases ~ 200 million EUAs <u>at 10 EUR/EUA</u>
Total: EUR 2 billion /year
versus
Purchases ~ 200 million CERs
<u>at 7.5 EUR/CER</u>
Total: EUR 1,5 billion/year
Total quasi-arbitrage: 0,5 billion/year

The above high level analyses show the logic of achieving arbitrage or quasi-arbitrage in the EU ETS Phase II. Based on the review of the National Allocation Plans of each of the ETS participating countries and the detailed assessment of the LCs of each of the ETS countries a more accurate assessment can be provided for the arbitrage option.

Table 9: Verified emissions and linking capacities

Country	Cap (Mt/yr)	Average free allocation Phase 2 (Mt/y)	Average verified emissions (Mt/y)	Credit limit (%)	Credit limit (Mt/yr)	Total credit limit (Mt)
Austria	31	32	30	10	3	15
Belgium	59	56	49	8	5	25
Bulgaria	42	38	36	13	5	26
Cyprus	6	5	5	10	1	3
Czech Republic	87	86	76	10	9	43
Denmark	25	24	25	17	4	21
Estonia	13	12	13	0	0	0
Finland	38	37	36	10	4	19
France	132	130	113	14	18	89
Germany	452	400	451	20	90	452
Greece	68	65	63	9	6	31
Hungary	28	25	24	10	3	14
Ireland	22	20	18	10	2	11
Italy	202	207	196	15	30	151
Latvia	6	4	3	10	1	3
Lichtenstein	0	0	0	0	0	0
Lithuania	9	8	6	20	2	9
Luxembourg	3	2	2	10	0	1
Malta	2	2	2	10	0	1
Netherlands	88	84	82	10	9	44
Norway	15	8	19	20	3	15
Poland	209	204	199	10	21	104
Portugal	35	31	26	10	4	17
Romania	76	74	52	10	8	38
Slovakia	33	32	23	7	2	11
Slovenia	8	8	8	16	1	7
Spain	152	151	138	20	31	152
Sweden	23	22	20	10	2	11
United Kingdom	246	219	238	8	20	98
Total	**2 104**	**1 986**	**1 950**		**282**	**1 412**

Legend		
		Losers
		Winners

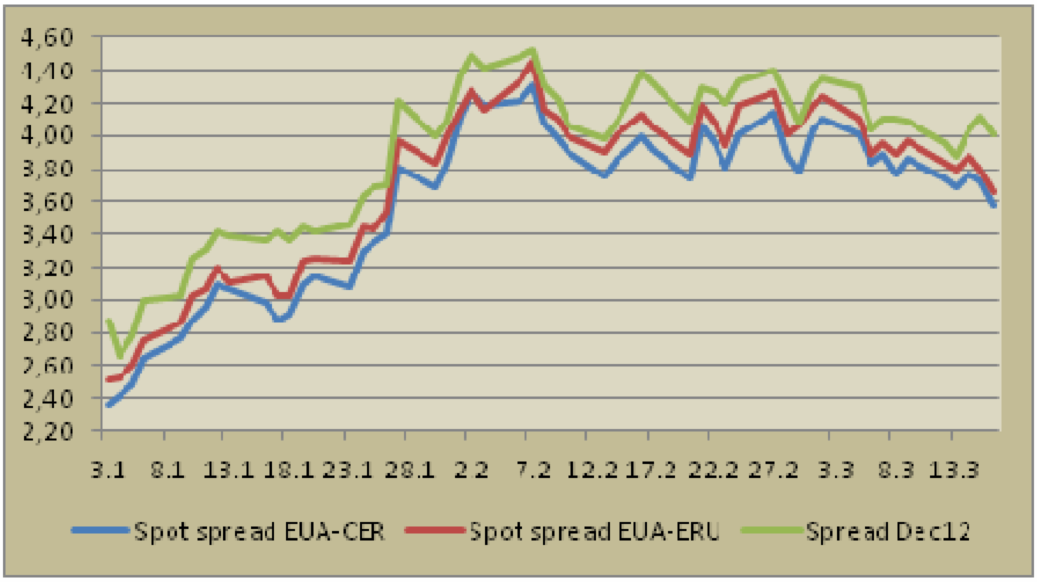
Source: EEA, ETS National Allocation Plans, own assessment

Based on the assessment of free allocations, verified emissions and Linking Capacities in the ETS it is to be seen that most countries' actual average emissions were below their freely received emission allowances. Some of the countries had their emissions just covered by free allocations and only three countries needed to purchase additional allowances on the market, namely UK, Norway and Germany.

The present assessment is not to question the allocation methodologies but to assess the actual arbitrage option per country. Based on this, there were 19 countries in which the ETS participants could achieve arbitrage (through selling the freely allocated EUAs and purchasing CERs making use of SWAP deals) and 3 countries in which the ETS participants could achieve the quasi-arbitrage option (through purchasing CERs instead of EUAs).

It is to be highlighted that there are no clear indications on the total arbitrage experienced in emission trade and thus the analysis indicates a potential financial value of profits in the respective countries of the European Union. Nevertheless, based on the number of surrendered Kyoto credits in the European Union it is to be noted that nearly the entire credit limit (see next table) has been utilized. Based on this deductive logic nearly the entire arbitrage potential has been realized by the emitting industries of the Union. It is also to be noted that for the sake of quantification of the arbitrage potential a rather conservative spread has been used for the EUA/CER price differences (EUR 2,5) meanwhile it reached to nearly EUR 4,5 level in 2012 and the opening of the gap continued in 2013.

Figure 26: EUA-CER spread in Q1 2012



Source: Saga Commodities

Assessing the total arbitrage potential of the EU ETS resulting from the linkage to the UN's Kyoto system the actual data are provided for the linking capacity of each of the countries in the ETS. Based on this the average yearly Linkage Capacity, taking 10 EUR/EUA and 7,5 EUR/CER as benchmark average prices the arbitrage potential of the ETS participants of each of the ETS countries are as follows:

Table 10: Arbitrage potential through SWAP mechanism

Country	Cap (Mt/yr)	Average free allocation Phase 2 (Mt/y)	Average verified emissions (Mt/y)	Credit limit (%)	Credit limit (Mt/yr)	Arbitrage potential (MEUR/y)
Austria	31	32	30	10	3	8
Belgium	59	56	49	8	5	12
Bulgaria	42	38	36	13	5	13
Cyprus	6	5	5	10	1	2
Czech Republic	87	86	76	10	9	22
Denmark	25	24	25	17	4	11
Estonia	13	12	13	0	0	0
Finland	38	37	36	10	4	10
France	132	130	113	14	18	45
Germany	452	400	451	20	90	226
Greece	68	65	63	9	6	15
Hungary	28	25	24	10	3	7
Ireland	22	20	18	10	2	6
Italy	202	207	196	15	30	76
Latvia	6	4	3	10	1	2
Lichtenstein	0	0	0	0	0	0
Lithuania	9	8	6	20	2	5
Luxembourg	3	2	2	10	0	1
Malta	2	2	2	10	0	1
Netherlands	88	84	82	10	9	22
Norway	15	8	19	20	3	8
Poland	209	204	199	10	21	52
Portugal	35	31	26	10	4	9
Romania	76	74	52	10	8	19
Slovakia	33	32	23	7	2	6
Slovenia	8	8	8	16	1	3
Spain	152	151	138	20	31	76
Sweden	23	22	20	10	2	6
United Kingdom	246	219	238	8	20	49
Total	**2 104**	**1 986**	**1 950**		**282**	**706**

Source: EEA, ETS National Allocation Plans, own assessment

The total average yearly arbitrage potential in the EU ETS Phase II was around EUR 700 million per year which provides an indicative magnitude of EUR 3,5 billion for the years 2008-2011. Out of the EUR 3,5 billion potential arbitrage value, a total of 1,4 billion as quasi and 2,1 billion as real arbitrage could have been realized.

The picture becomes even more interesting resulting from the latest price movements of the emission markets as the EUA prices have been around 7 EUR/EUA in the last year meanwhile CER prices have continuously fallen and reached to around 1 EUR/CER by the end of 2012. Obviously the gap has opened up and for 2012 derived from the above shown methodologies even higher arbitrage rates could have been concluded for the year 2012. The prices of EUAs stood around 7 EUR and around 1 EUR for CERs which means the gap opened to around 6 EUR/allowances at the end of 2012.

Table 11: Total arbitrage potential in the EU ETS

Country	Cap (Mt/yr)	Credit limit (%)	Credit limit (Mt/yr)	Arbitrage potential (MEUR)
Austria	31	10	3	**19**
Belgium	59	8	5	**29**
Bulgaria	42	13	5	**31**
Cyprus	6	10	1	**4**
Czech Republic	87	10	9	**52**
Germany	452	20	90	**542**
Denmark	25	17	4	**25**
Spain	152	20	31	**183**
Estonia	13	0	0	**0**
Finland	38	10	4	**23**
France	132	14	18	**107**
United Kingdom	246	8	20	**118**
Greece	68	9	6	**37**
Hungary	28	10	3	**17**
Ireland	22	10	2	**13**
Italy	202	15	30	**181**
Lithuania	9	20	2	**11**
Luxembourg	3	10	0	**2**
Latvia	6	10	1	**4**
Malta	2	10	0	**1**
Netherlands	88	10	9	**52**
Norway	15	20	3	**18**
Poland	209	10	21	**125**
Portugal	35	10	4	**21**
Romania	76	10	8	**46**
Slovakia	33	7	2	**14**
Slovenia	8	16	1	**8**
Sweden	23	10	2	**13**
Total	**2 104**		**282**	**1 695**

Source: National Allocation Plans, own assessment

It means the opening of the gap between the two products result in about EUR 1,7 billion arbitrage potential for the ETS entities in 2012.
Based on the latest data 256 million CER/ERU have been surrendered in 2011 meaning that the covered entities were able to utilize about 90 % of their total credit limit implying that the quasi and real arbitrage option have been nearly fully utilized. Undeniably, most of the countries voted to connect the two systems (Kyoto and the EU ETS) through the Linking Directive and resultantly made their entities able to make use of Kyoto credits in their emission reduction activities in the European Union. Hence, the EU gave the opportunity to their covered entities in finding a cheaper way to meet emission targets.

Regulation gave this opportunity to the entities but regulation was not prepared to quantify the real economy level effects of the SWAP option. As of this analysis billions of Euros have gone to the pocket of GHG emitting industries as arbitrage or quasi arbitrage. Based on the questions raised over the validity of emission reductions achieved through the Kyoto mechanisms the EU has seriously decreased the linking capacity of the EU ETS phase III and resultantly the space for arbitrage.

For the Phase III as the Directive put it:

"All existing operators shall be allowed to use credits during the period from 2008 to 2020 up to either the amount allowed to them during the period from 2008 to 2012, or to an amount corresponding to a percentage, which shall not be set below 11 %, of their allocation during the period from 2008 to 2012" (**EC, 2009**).

Meaning that, the amount of the potential arbitrage will be lower but as a financial tool it will be further available in the hands of operators. The total magnitude for this in Phase III, taking the 6 EUR/allowance difference as benchmark is assessed as the following:

Table 12: Arbitrage potential in the 3rd Phase of the ETS

Country	Additional Credit in Phase 3 (Mt)	Arbitrage potential (MEUR)
Austria	2	9
Belgium	8	46
Bulgaria	0	0
Cyprus	0	2
Czech Republic	4	26
Denmark	2	11
Estonia	7	44
Finland	2	12
France	0	0
Germany	0	0
Greece	7	41
Hungary	1	8
Ireland	1	6
Italy	9	53
Latvia	0	2
Lichtenstein	0	0
Lithuania	0	0
Luxembourg	0	1
Malta	0	1
Netherlands	4	26
Norway	0	0
Poland	10	62
Portugal	2	10
Romania	4	23
Slovakia	7	39
Slovenia	0	0
Spain	19	112
Sweden	1	7
United Kingdom	29	175
Total	**119**	**713**

Source: own assessment

The logic for the 3rd Phase as quoted above is to allow the utilization of the Phase II Linking Capacities and maximize the total amount in 11 % of the allocation for 2008-2012. It means the arbitrage potential although narrowed but may give space to additional EUR 700 million financial profits 2013-2020.

Arbitrage is not a fraud it is a well known option in every organized market platforms. Those participants which have deeper market understanding or market insights could and can make use of this financial tool to create profits without value added production but through financial trading mechanisms. In the case of emission trading this option can be hardly defended as it can be seen through the free allocation, verified emissions and linkage capacities that some of the countries did not face any obligation for market purchases because of the fact that they could cover their liabilities with the freely received quotas. Further to this they were able to SWAP the freely received EUA quotas to CERs and resultantly create windfall profits through the multinational emission trading system without any climate protective actions initiated.
On the one hand with the linkage to the UN system the EU saved the Kyoto Protocol but on the other hand created the space for diplomatically phrased unfair practice of emission trade accounting for billions of financial profits generated to ETS entities neglecting climate protection the ultimate target of the ETS.

Short conclusion: future of arbitrage option

Meanwhile the EU has tightened the space for arbitrage in Phase III of the ETS by setting stricter credit limits there is no clear indication how the price differences of the ETS and the Kyoto trading activities could be handled on the long run leaving questions around why the Linking Directive does not solve this pure financial profit generating potential of the multinational emission trading systems

5.2 Potential value of fraudulent or unfair practices in emission trade

It has to be highlighted that some of the practices are only unfair that means entities have not breached any laws or regulations when accomplishing them. The analysis targets to summarize each type of activities that have been utilized to generate financial incomes without any targeted efforts reducing greenhouse gas emissions. Fraudulent or unfair practices in emission trade are those which generate financial profits to participants lacking any targeted emission reduction activities and in several cases are considered criminal.

Two main criminal practices have been identified namely the missing trader or carousel fraud and cyberthefts. Both have been known criminal practices to tax and police authorities thus these do not connect only to practices in emission trading systems, nevertheless some criminal groups could make use of the immature regulation of emission trading regimes.

Three main unfair practices have been identified namely allowance recycling, overvaluation or additionality problems, and arbitrage or quasi-arbitrage options. Each of them relate solely to the emission trading systems and have not been known by authorities before emission trading has commenced.

A summary of the unfair practices is provided in the following.

Table 13: Potential magnitude of criminal and unfair practices in emission trade

Activity / Loss (EUR million)	Criminal	Unfair
Carousel fraud	6 763	
Phishing, hacking	40	
Allowance recycling		20
Overvaluation/additionality		4 000
Arbitrage		4 264
Total	**6 803**	**8 284**

Source: Own analysis

Based on the assessment of the World Bank the carbon market as a whole has reached the financial value of EUR 126 billion in 2011 (**WB, 2012**) that is an unprecedented size. Nevertheless, the value of fraudulent or unfair practices amounted to EUR 15 billion as of the present analysis which is above 10 % of the total trading value of 2011. It has to be noted that this amount was to be revealed through this analysis but almost certainly at least the same financial value can be accounted for remaining latent in the system potentially increasing the total value of these practices to be above EUR 30 billion in the short existence of emission trade since its ignition in 2005.

Table 14: Total potential value of fraudulent and unfair practices in emission trade until 2012

Country / EUR million	Carousel fraud	Phishing, hacking	Allowance recycling	Overvaluation/ additionality	Arbitrage & quasi-arbitrage
Austria		5			50
Belgium					78
Bulgaria					83
Cyprus					10
China				2500*	
Czech Republic	20	7			139
Denmark					67
Estonia					
France	1800				285
Germany	850				1446
Greece					98
Hungary			20		45
India				1500*	
Italy					483
Netherlands					139
Norway	43				48
Poland					334
Romania		28			122
Spain	50				488
Sweden					35
UK	4000				314
TOTAL per activity	**6 763**	**40**	**20**	**4 000**	**4 264**
TOTAL					
EUR 15 087 million					

Source: own analyses

The summary table indicates only the revealed total value of activities which did not trigger real emission reduction activities based on the investigation executed in the research. The latent value of fraudulent/unfair practices can account for at least the same amount of the identified EUR 15 billion accounting to around EUR 30 billion as a total nevertheless there has not been further evidence identified on the value of latent unfair practices.

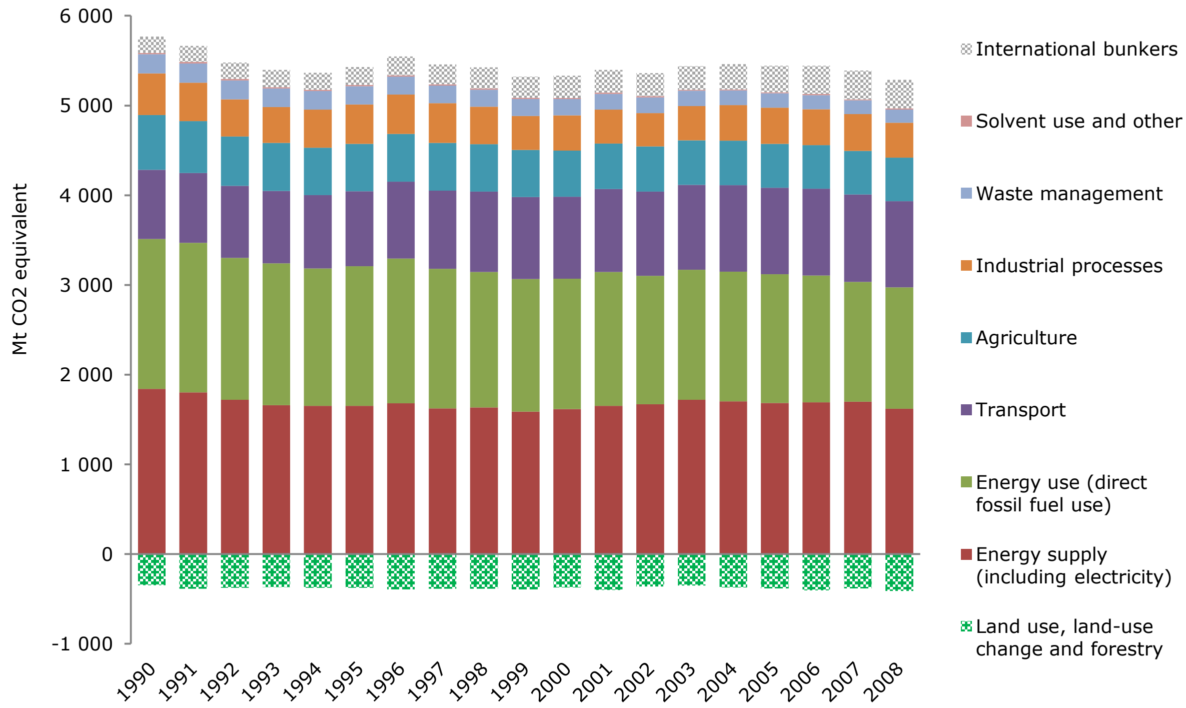
* In case of India and China the potential total EUR 4 billion revenue generated through CDM has been proportionally divided and no further analytical analyses have been executed.

5.3 Effects of Regional Fuel Price Differences in Multinational Emission Trade Systems

The EU ETS system is a common system for EU member states which targets at enforcing greenhouse gas emission reduction through implying a standard cost of each unit of greenhouse gas emissions (EUR/tCO2eq).

The energy sector is one of the biggest emitters of the GHGs of the Union that means an enormous magnitude and subsequently provides a great potential to cut the emissions of the Community.

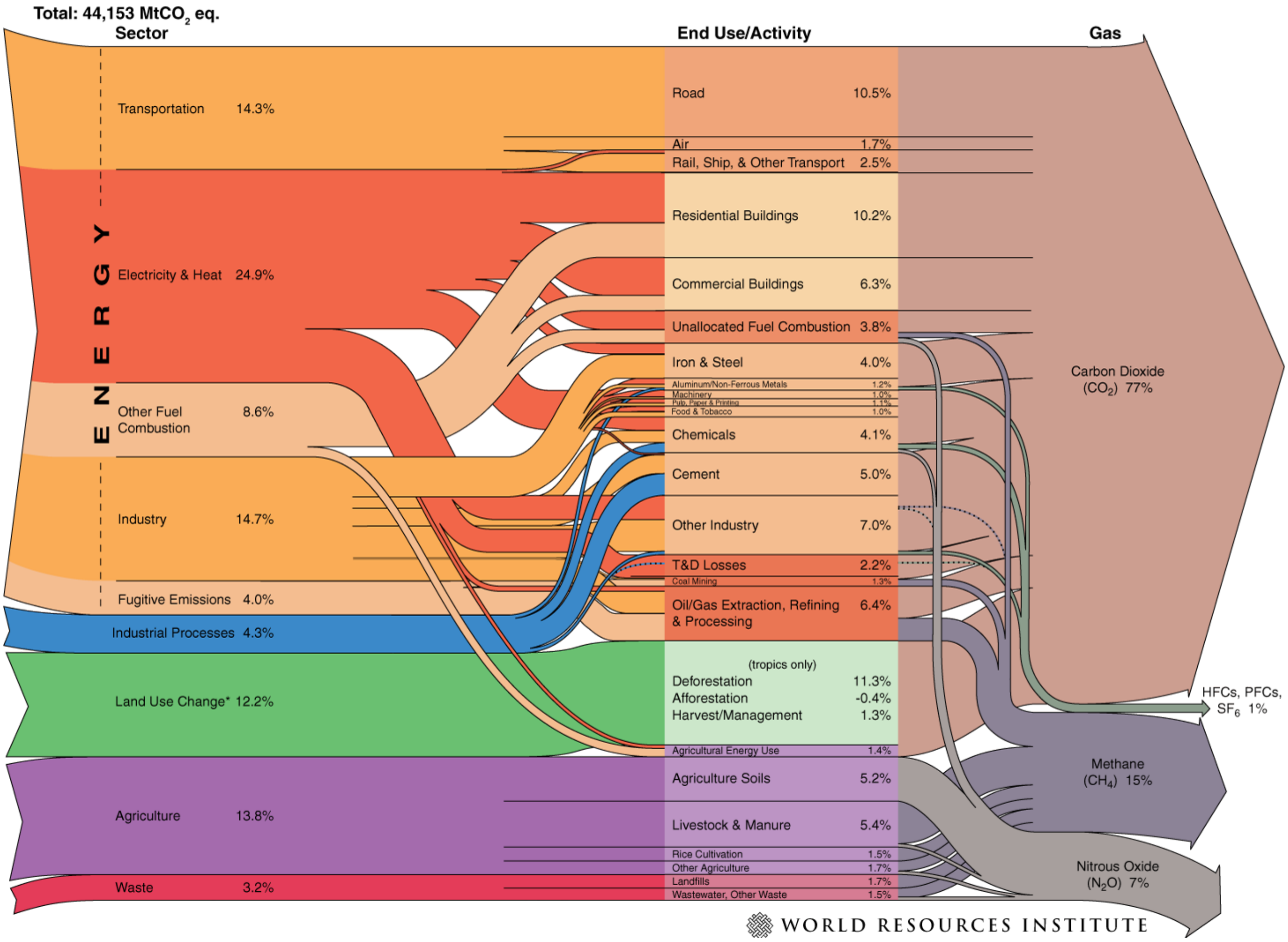
Figure 27: EU GHG emissions by sector



Source: EEA

The role of the energy sector in GHG emissions is very similar to that of the EU's on the global level too.

Figure 28: World GHG emissions in 2005



Source: World Resources Institute

As shown on the above graphs more than half of the emissions are related to energy supply and energy use.

The EU ETS covers primarily the energy supply sector and the big energy consumer industries. The ETS results in extra costs to the energy supply industry through pricing each ton of CO2 emissions and thus drives the participants of the sector to decrease their GHG emissions. The price of emission units is equal to all of the emitters including power plants as standard quotas are traded on international exchange platforms. The price of a unit is fluctuating as it is experienced on any type of mature exchange market and results in a certain price level at any point of time based on the supply and demand equilibrium of the market. It has an effect that has to be assessed in the following.

Central philosophy of emission trading is that it provides a market based tool to cut emissions of industries in a cost efficient manner as discussed thoroughly in previous chapters of the dissertation. The least cost emission reductions shall be achieved through the natural cost minimizing strategies of profit-oriented companies emitting GHGs.
The power sector has a feature that limits cost optimization strategies of power generators, namely its geographic limitations. Although power can be transmitted through distances there are issues with transmission losses. Further to this limitation the availability of a strong power generation sector in each sovereign countries is a major national and energy security issue. Hence, power generators are geographically limited in their cost optimization strategies. This will have a major influence on the effects of a standard CO2 burden in a multinational emission trading regime which may even result in contra productive outcomes in terms of CO2 abatement to be discussed in detail in the following.

The business decision of power producers, similarly to the decision of industrial producers on business continuity depends on the case of marginal costs and incomes. If the marginal income of the production of any product is higher than the marginal cost of production then the business commences but when the marginal costs are above the marginal income that results in cancellation of operation. This is similar in the case of CO2 costs.

When the marginal income is above the marginal cost of production, including marginal cost of emissions, than production commences but as soon as the marginal cost of emission is above the marginal incomes then the operation needs to stop. Evidently, the power sector has its options to substitute technologies to avoid additional emissions and thus the operation does not have to be stopped but alternative generation techniques need to be introduced such as renewable energy sources which have mostly zero GHG emissions. It has to be noted that renewable energy sources can have GHG emissions but the present regulation in energy policies across the world do not pose any obligation on renewable based power generation techniques in respect to CO2.
The policy of a standard CO2 cost burden is a fair intervention in general and it is claimed that this tool is the one that is best able to persuade energy producers to shift their fossil fuel based production to less GHG intensive options.

Each fossil fuel type has its particular emission factor, brown coal or lignite has one of the highest (101,1 tCO2/TJ) and natural gas (56,1 tCO2/TJ) has one of the lowest emission factors (**EC, 2007**). As stated above renewable may have also CO2 emissions, e.g in the case of biomass fueled power generation but this is not taken into account based on the life cycle assessment of biomass resources.

Table 15: Fuel emission factors related to net calorific value (NCV) and net calorific values per mass of fuel

Fuel type description	Emission factor (tCO2/TJ)	Net calorific value (TJ/Gg)
Crude oil	73,3	42,3
Natural gas liquids	64,1	44,2
Motor gasoline	69,2	44,3
Kerosene	71,8	43,8
Shale oil	73,3	38,1
Gas/diesel oil	74,0	43,0
Residual fuel oil	77,3	40,4
Liquefied petroleum gases	63,0	47,3
Ethane	61,6	46,4
Naphtha	73,3	44,5
Bitumen	80,6	40,2
Petroleum coke	97,5	32,5
Refinery gas	51,3	49,5
Other petroleum products	73,3	40,2
Anthracite	98,2	26,7
Coking coal	94,5	28,2
Other bituminous coal	94,5	25,8
Sub-bituminous coal	96,0	18,9
Lignite	101,1	11,9
Oil shale and tar sands	106,6	8,9
Patent fuel	97,5	20,7
Coke oven coke and lignite	107,0	28,2
Gas works gas	44,7	38,7
Coke oven gas	44,7	38,7
Blast furnace gas	259,4	2,5
Oxygen steel furnace gas	171,8	7,1
Natural gas	56,1	48,0
Industrial wastes	142,9	n.a.
Waste oils	73,3	40,2
Peat	105,9	9,8

Source: EC

Looking into the details, the CO_2 cost cannot be entirely detached from other operating expenditures of industries, especially fuel costs. Fuel costs and fuel emission factors are paramount both from a technical and financial perspective.

Standard CO_2 prices throughout the EU or in any multinational context result in a deficiency in respect to equal development potentials of different geographical regions. As described above the fuel and the CO_2 price, and also CAPEX and OPEX costs, together influence the decision of the power producers. As described also above, the CO_2 price is standard and thus does not make any difference throughout Europe, i.e. the cost of one ton emission is the same for all of the emitters at a certain point of time. The difference for power producers is based on the fuel costs, emission factor of the fuel and power generation efficiency. If a producer uses less carbon intense fuel sources or has a higher efficiency for power generation than its carbon emission is lower compared to less efficient more carbon intense power producers.

Although the cost of emission is a standard but the fuel price has considerable differences that has a major effect on power sector development and its negative effects are experienced mainly in the less developed CEE part of the European Union which have long term contracts signed with the Russian Gazprom. As reviewed in the study this is a status quo of the EU power generation sector and the reason for this study to be developed was the understanding of the fuel price difference phenomenon. It is supposed that this price difference may be disappearing in the future fuel market of the European Union but as I see if it happened within the boundaries of the EU than it will evolve in any future global emission markets and will do so until the point when same fuel prices will be realized in all of the countries of the world.

5.3.1 Modeling approach for analyzing the effects of fuel prices on CO_2 avoidance in case of power plants

The following section describes the steps of model development and the ways in which the model can be made use of for analyzing the effects of regional fuel price differences on GHG emission mitigation in case of a standard CO_2 cost burden per unit of emission. The present analysis evaluates the case for coal and natural gas. These fuels entail the two ends of fossile type of fuel sources having the lowest CO_2 emissions on the side of natural gas and the highest for coal. Further to this, the developed methodology is usable for assessing the breakeven of renewable energy sources compared to fossil fuels in the power generation sector. Nevertheless, this study details the case for gas and coal.

Step 1: identification of fuel types to be analyzed as benchmarks

Fuel
Coal
Natural gas

Coal and natural gas provide the two ends of carbon intensity of various fossil fuel types and thus can be effectively used for representation but comparisons are viable for any other type of fuels.

Step 2: Identification of the comparative sample

Fuel
Coal (spot)
Natural gas (spot)
Hungarian lignite
Gazprom gas (indexed)

As second step alternative fuels/ regional fuel prices need to be identified for which the comparison of CO2 marginal costs shall be analyzed.

Step 3: Price setting of fuels analysed

Fuel	Fuel price (EUR/MWh)
Coal (spot)	9,35
Natural gas (spot)	29
Hungarian lignite	5,88
Gazprom gas (indexed)	34

Prices are indicative for the end of the year 2012. Sources of information are exchange platforms such as EEX, power plants such as Mátra Power Plant in Hungary, traders such as Sourcing Hungary or professional consultants such as KPMG.

Step 4: Assigning power plant efficiencies in respect to each type of fuels

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)
Coal (spot)	9,35	43,00%
Natural gas (spot)	29	55,00%
Hungarian lignite	5,88	32,00%
Gazprom gas (indexed)	34	55,00%

Efficiencies are indicative and can vary in case of particular generation facilities. Data sources for power plant efficiencies are IEA as international association or consultancies as KPMG.

Step 5: Identifying the fuel cost for generating unit of power

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)
Coal (spot)	9,35	43,00%	21,74
Natural gas (spot)	29	55,00%	52,73
Hungarian lignite	5,88	32,00%	18,38
Gazprom gas (indexed)	34	55,00%	61,82

Logic of deriving fuel cost on power is as follows: unit cost of fuel divided by power plant efficiency describing the actual fuel cost in various power generation options for generating a unit of power.

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)
Coal (spot)	9,35	43,00%	21,74
Natural gas (spot)	29	55,00%	52,73
Hungarian lignite	5,88	32,00%	18,38
Gazprom gas (indexed)	34	55,00%	61,82

$$MC_f = P_f / E_{pp}$$

MC_f: Marginal cost of fuel generating unit of power (EUR/MWh)

P_f: Price of fuel (EUR/MWh)

E_{pp}: Power generation efficiency (%)

Step 6: identification of the fuel cost ratio to the total OPEX of power generation per unit of power

Fuel type user	PP fuel cost/total cost (%)
Natural gas	90,00%
Coal	40,00%

Fuel per total OPEX is an indication based on IEA's projected cost of generating electricity and consultancy sources such as KPMG. Interestingly, there are power plants that bear higher investment needs upfront in CAPEX and face lower costs on OPEX. The ratio is required in identifying the cost of generating power.

$$R_{ft} = MC_f / MC_p$$

R_{ft}: ratio of fuel cost to OPEX costs (%)

MC_f: Marginal cost of fuel generating unit of power (EUR/MWh)

MC_p: Marginal cost of generating unit of power (EUR/MWh)

Step 7: Identification of the marginal cost of generating a unit of power

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)	Total power cost (EUR/MWh)
Coal (spot)	9,35	43,00%	21,74	54,36
Natural gas (spot)	29	55,00%	52,73	58,59
Hungarian lignite	5,88	32,00%	18,38	45,94
Gazprom gas (indexed)	34	55,00%	61,82	68,69

Fuel type user	PP fuel cost/total cost (%)
Natural gas	90,00%
Coal	40,00%

Based on the input data and ratios of fuel costs in total costs and the power costs on fuel the total power costs can be assessed.

$$MC_p = MC_f / R_{ft}$$

Step 8: Identification of emission factors of the fuels in scope

Fuel	emission factor (kg/GJ)
Coal (spot)	94,5
Natural gas (spot)	56,1
Hungarian lignite	101,1
Gazprom gas (indexed)	56,1

Each fuel has its particular emission factor which can be identified. In case of particular power plants the concrete emission factor can be analyzed. For the sake of this analysis the IPCC 2006 guidelines have been used which is also used by the European Commission.

$$EF_f \text{ (kg/GJ)} = \text{CO2 quantity (kg) / energy content of fuel (GJ)}$$

EF_f: Emission factor - fuel

Step 9: Unit conversion to mirror back the same and comparable quantities

Fuel	Emission factor (kg/GJ)	Emission factor fuel (t/MWh)
Coal (spot)	94,5	0,34
Natural gas (spot)	56,1	0,20
Hungarian lignite	101,1	0,36
Gazprom gas (indexed)	56,1	0,20

As the power generation is measured in MWh the GJ based emission factors need to be normalized to the same unit as follows:

$$\text{(kg/GJ) / 0,2778 / 1000 = t / MWh.}$$

$$EF_f \text{ (t/MWh)} = \text{CO2 quantity (t) / energy content of fuel (MWh)}$$

Step 10: Identifying power plant emissions per generated unit of power

Fuel	PP Efficiency (%)	Emission factor fuel (t/MWh)	PP emission (t/MWh)
Coal (spot)	43,00%	0,340172786	0,791099503
Natural gas (spot)	55,00%	0,201943844	0,367170626
Hungarian lignite	32,00%	0,363930886	1,137284017
Gazprom gas (indexed)	55,00%	0,201943844	0,367170626

Logic of identifying actual power plant emissions is as follows:

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)	Total power cost (EUR/MWh)	Emission factor (kg/GJ)	Emission factor fuel (t/MWh)	PP emission (t/MWh)
Coal (spot)	9,35	43,00%	21,74	54,36	94,5	0,340172786	0,791099503
Natural gas (spot)	29	55,00%	52,73	58,59	56,1	0,201943844	0,367170626
Hungarian lignite	5,88	32,00%	18,38	45,94	101,1	0,363930886	1,137284017
Gazprom gas (indexed)	34	55,00%	61,82	68,69	56,1	0,201943844	0,367170626

The ratio of emission factor and power plant efficiency describe the actual emissions per unit of power generated (MWh).

$$ME_{pp} \text{ (t/MWh)} = EF_f \text{ (t/MWh)} / E_{pp} \text{ (\%)}$$

ME_{pp}: Power plant marginal emission on generating a unit of power

Step 11: Introduction of CO2 price as a variable in the model

CO2 price (EUR/t)	0	10	20	30	40	50	60	…

Indicative levels of CO2 prices are input to the model. For the depth of the study the decimal steps are adequate but any specific price levels can be input to the analysis.

P_{CO2}: CO2 price (EUR/t)

Step 12: Assessment of power generation's total cost per each level of CO2 price

CO2 price (EUR/t)	0	10	20	30	40	50	60	…
Total PP (EUR/MWh)								
Coal	54,36	62,27	70,18	78,09	86,00	93,92	101,83	
Natural gas	58,59	62,26	65,93	69,60	73,27	76,94	80,62	
Hungarian lignite	45,94	57,31	68,68	80,06	91,43	102,80	114,17	
Gazprom gas	68,69	72,36	76,03	79,70	83,37	87,05	90,72	

Logic of the computation is as follows:

Fuel	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)	Total power cost (EUR/MWh)	Emission factor (kg/GJ)	Emission factor fuel (t/MWh)	PP emission (t/MWh)
Coal (spot)	9,35	43,00%	21,74	54,36	94,5	0,340172786	0,791099503
Natural gas (spot)	29	55,00%	52,73	58,59	56,1	0,201943844	0,367170626
Hungarian lignite	5,88	32,00%	18,38	45,94	101,1	0,363930886	1,137284017
Gazprom gas (indexed)	34	55,00%	61,82	68,69	56,1	0,201943844	0,367170626

CO2 price (EUR/t)	0	10	20	30	40	50	60
Total PP (EUR/MWh)							
Coal	54,36	62,27	70,18	78,09	86,00	93,92	101,83
Natural gas	58,59	62,26	65,93	69,60	73,27	76,94	80,62
Hungaian lignite	45,94	57,31	68,68	80,06	91,43	102,80	114,17
Gazprom gas	68,69	72,36	76,03	79,70	83,37	87,05	90,72

$$TMC_p \text{ (EUR/MWh)} = MC_p + (ME_{pp} \times P_{CO2})$$

TMCp : Total marginal cost of generating power incl. fuel, CO2, and power generation efficiency

The model computes the cost of generating electricity for each level of CO2 prices set earlier based on the total power costs and power plant emissions per unit of electricity produced and CO2 costs.

Step 13: Graphical representation of the findings

Based on the numerical and graphical representation of the findings the differences in breakeven for less polluting natural gas can be described compared to the dirtier coal resources.

5.3.1.1 Limitations of the modeling approach

It has to be highlighted that the power sector is a more complex business that is to be evaluated solely through the marginal cost approach focusing on coal and natural gas fuelled generation. The power price evolution is derived from supply-demand equation of the entire sector including other types of power generation facilities such as nuclear power, renewable energy sources, oil, etc. The present model is not a power price forecasting tool but a tool for comparative analysis to identify the breakeven of the cleaner natural gas compared to the dirtier coal in respect to different price levels of CO2. In the case of power sector development the available infrastructure is crucial meaning that a theoretical analysis may reveal that selecting another fuel could generate more profits if that fuel is not available. In this case, transportation costs are higher and resultantly the competitiveness of power generation need to be adjusted to the extra costs of logistics.

It is to be noted that the results of the model do not straightforward imply a standard development path of the power generation sector in the respective countries of the analysis. The availability of resources, infrastructure, historical development paths, technology knowledge and R+D are all interrelated influential factors in the natural development of any local or regional power systems. Thus the findings of the model prescribe the interesting financial differences in the effects of the standard CO2 price on power producer companies.

Hence the model does not provide real forecast of power prices because those prices can only be derived from modeling the entire value chain of power producers, including nuclear, renewable, oil, etc that is not the purpose of the present analysis.

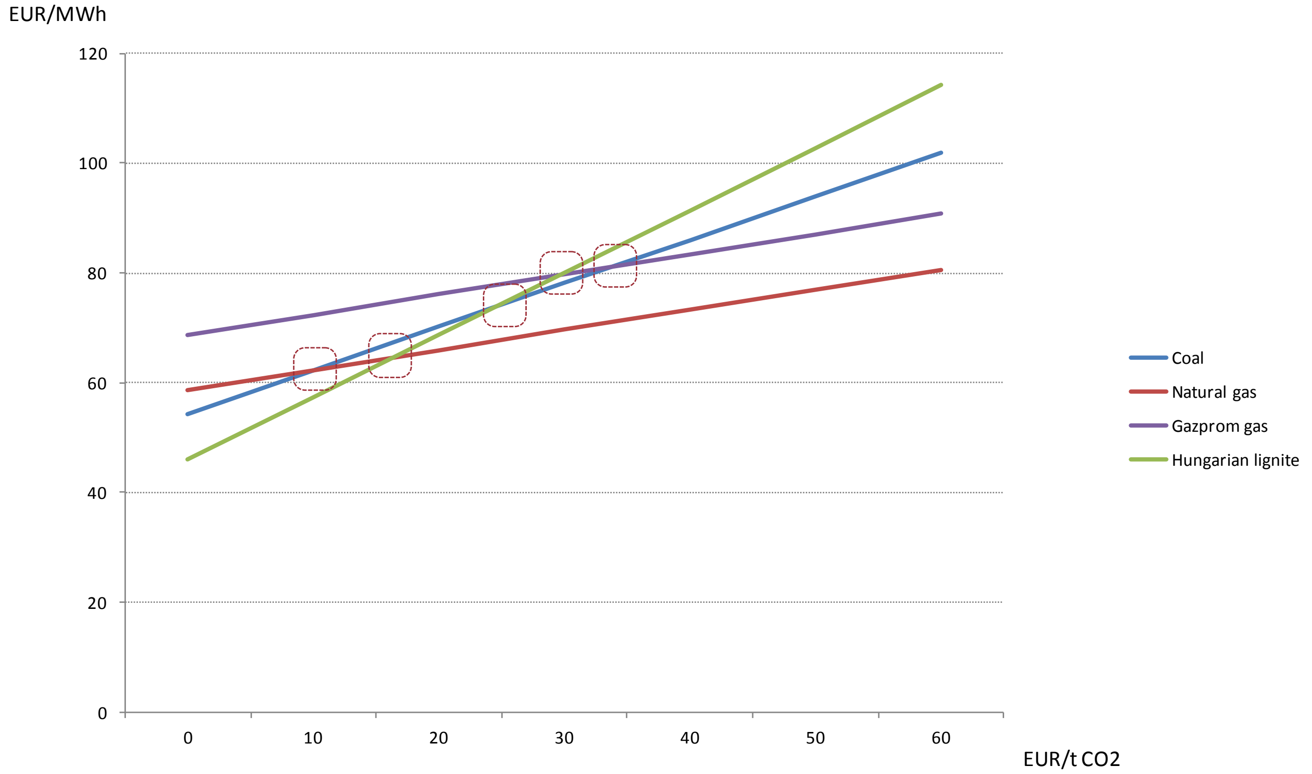
5.3.2 *Results of the fuel price differences on power generation assets in the European perspective*

One of the main drivers of the costs of energy producers is the fuel price which has considerable differences in the EU. The difference has a major effect on power sector development and its negative effects are experienced mainly in the less developed Eastern part of the region. Regional fuel price differences and their effects in case of a multinational emission trading system are dealt with under the operational defects of emission trade but not fraud or unfair practices.

Energy producers based in the CEE countries face less incentive to carbon emission abatement compared to their Western counterparties. Consequently, there is lack of intention to upgrade the energy infrastructure, especially power plants to more efficient and less GHG intensive types.
The power producers in the CEE experience higher fuel costs on the less CO2 intensive natural gas sources and lower costs on more CO2 intensive fuels such as brown coal compared to the Western-European counterparties and resultantly the more advanced Western regions became even more motivated to substitute carbon intensive coal based power generation compared to the utilities operating in the CEE region.

Describing this case a model was developed and made use of for analyzing competitiveness of Hungarian and Western-European natural gas, coal and lignite fuelled power generation facilities in view of different CO2 price levels. Natural gas is broken down to two different price levels as may be experienced through the decoupling of Western and Eastern European natural gas prices.

Figure 29: Illustration of power price competitiveness as a factor of different fuel and CO2 prices in different energy markets



Source: Own assessment

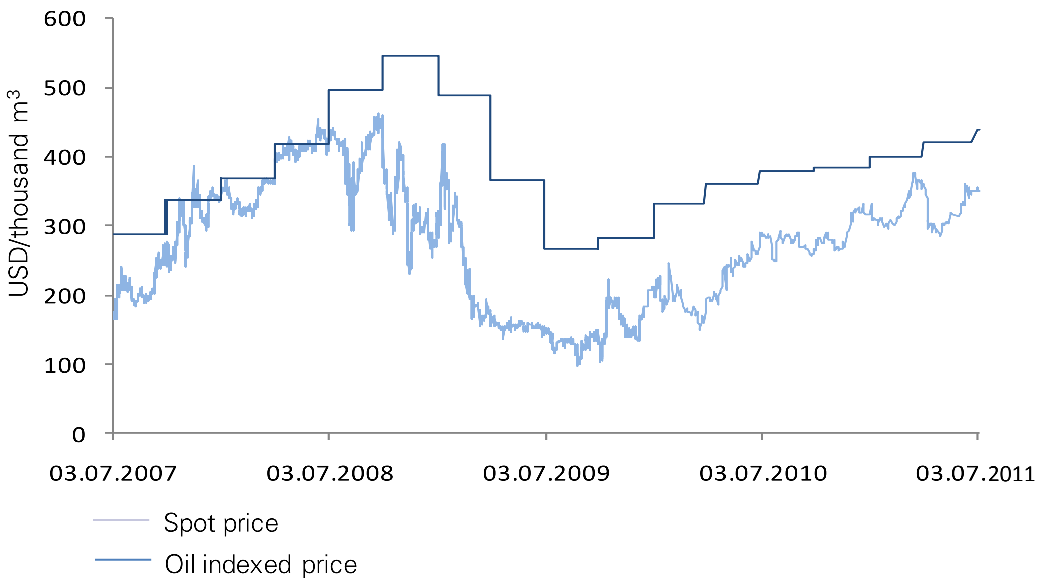
The reason for the deviation between same types of power generators' cost structures is the difference in the fuel purchase prices. On the one hand locally available lignite sources are well below the price of internationally traded coal products in Hungary, and on the other hand the natural gas price difference is derived from the difference of spot market price and long term oil price indexed natural gas. Based on the above price analysis the major conclusion to be drawn up is that different fuel prices highly influence the real effect of a standard CO2 trading system, such as the EU ETS, in respect to power price competitiveness. Power and energy price competitiveness has a major effect on the decision of power producers in respect to the utilization of different primary energy commodities and fuels.

Fuel prices have gone through a major reformation in the period 2008-2012 in relation to the slowdown of economy and the decreasing demand for primary energy. This has resulted in a drop of natural gas price but the drop was not equal in different regions of the European Union. Those countries which have a more mature liberalized commodities market experienced a higher drop in natural gas prices on the spot market as a result of decreasing demand and evolution of the supply and demand equilibrium. That was not the case in those countries which use long term pricing formulas for natural gas imports, such as the Gazprom formula utilized in respect to the Central and Eastern European countries. These imports are priced based on the Gazprom's natural gas formula as a moving weighted average of different oil commodities with a 9 month delay in its effect.

Pn = a * Po * (0,5 * F / Fo + 0,5 * G / Go) + b * (TTF + spread) * USD/EUR * 1,11 / 3,6 [USD/GJ] (**Sourcing, 2012**)

A widespread proportioning is based on the moving weighted average of heating and diesel oil pricing providing 60 % of the price (a) and 40 % weight is given to the spot market (b). Based on the comparison of the different fuel prices as at the end 2011 and beginning of 2012 major differences can be seen when drawing up the power prices generated by coal and natural gas using power plants. Major differences are also to be seen when comparing coal and natural gas users of Western- and Eastern-Europe.

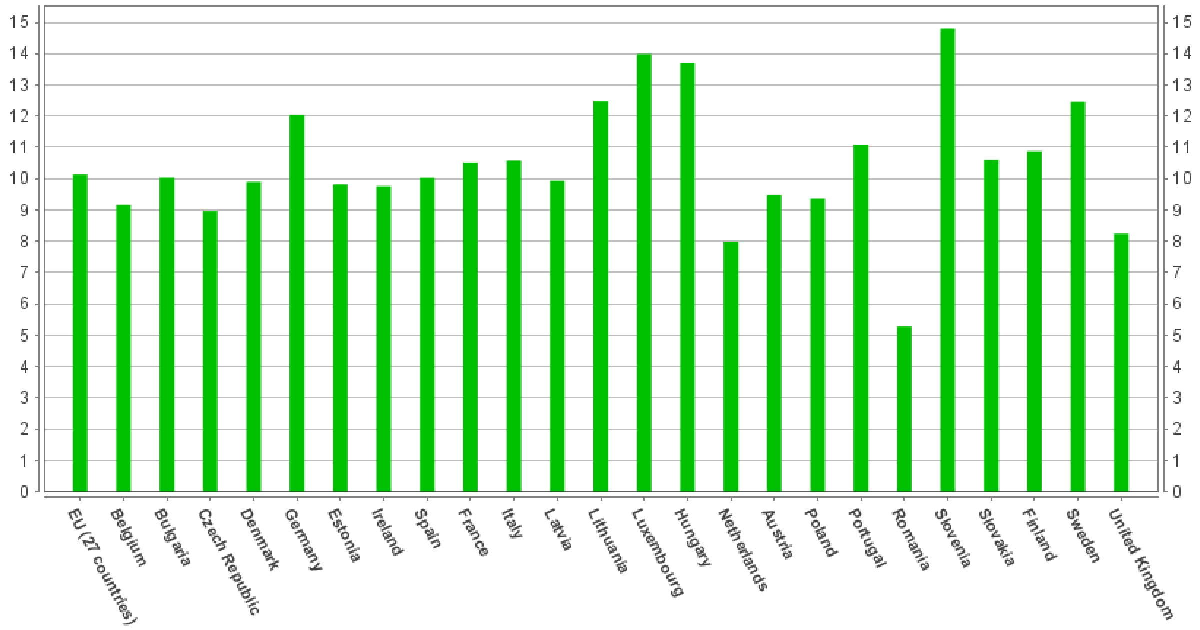
Figure 30: Divergence of different natural gas prices



Source: EEX, KPMG, Own assessment

The differences of indexed and spot pricing is an adequate example for describing reasons for diverging fuel prices in the European Union, nevertheless there may be various roots to price differences their effect on pricing GHG emissions in case of the power sector is not negligible.

Figure 31: EU Natural gas prices for industrial consumers (€/GJ)



Source: Eurostat

Somewhat surprisingly the cheapest Romanian natural gas sources cost only about one third compared to the most expensive Slovenian. A straightforward question arises from this comparative analysis, that how the standard CO2 price could bring the same outcome in countries with such differences in fuel price levels.

5.3.2.1 Model results: Hungary

The first analytical assessment of fuel price effects focuses on the case of the Hungarian power sector, comparing the competitiveness of locally available coal or lignite resources (**Valaska, 2012**) with natural gas resources stemming from Russia and being more precise it is the indexed Gazprom gas.

Table 16: Hungarian indexed natural gas and lignite prices

	Fuel price (EUR/MWh)
Fuel	
Hungarian lignite	5,88
Indexed gas	33,9

Source: Valaska, Opten, Sourcing, Own calculation

As discussed in detail in the modeling methodology, price effects are observable in relation to emission costs as a factor of the operating expenditures, power generation efficiency and emission intensity. Looking at the details the model prescribes the following price levels connected to the different emission costs.

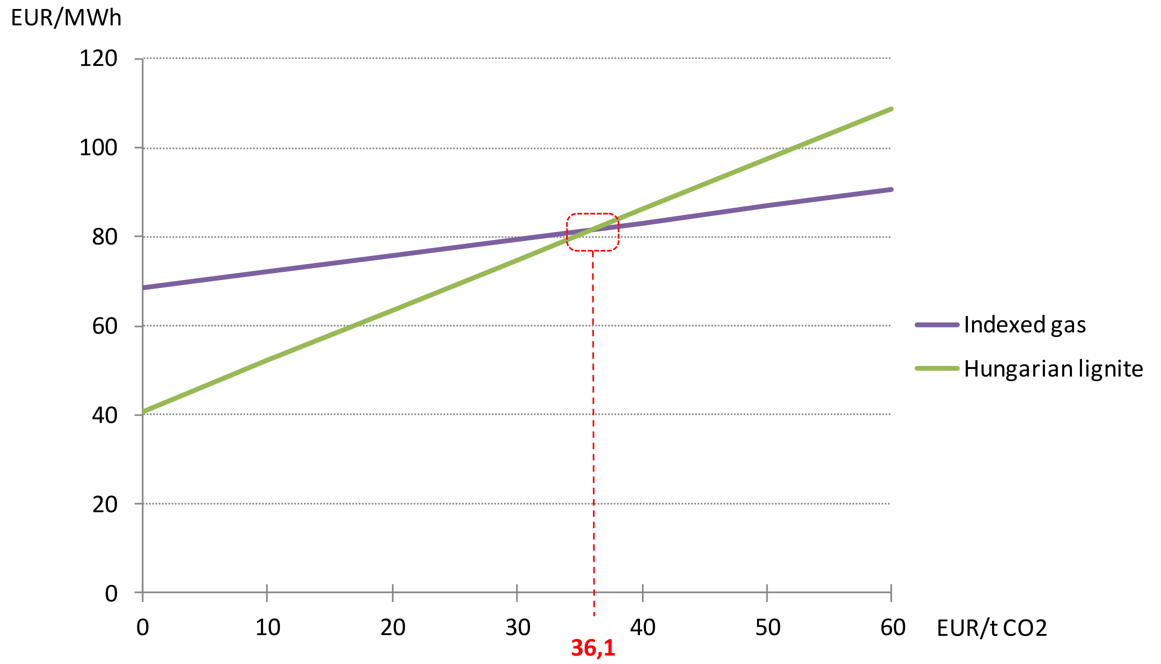
Table 17: Hungarian power prices derived for lignite and indexed natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Hungaian lignite	40,83	52,16	63,50	74,83	86,16	97,49	108,82	120,15	131,48	142,81
Indexed gas	68,48	72,16	75,83	79,50	83,17	86,84	90,52	94,19	97,86	101,53

Source: Own calculation

It can be seen on the table that it is worthwhile to use coal as fuel instead of natural gas till EUR 30 /tCO2 price level and it is already more profitable to switch to the cleaner natural gas above that. The exact breakeven is at EUR 36,1 /tCO2.

Figure 32: Power price competitiveness comparison of Gazprom gas and Hungarian lignite as a factor of CO2 price in Hungary



Source: Own calculation

The graphical representation highlights that in the case of Hungary the present price level of CO_2 (below EUR 5/ tCO_2) is not adequate to motivate coal fuelled power plants to switch to natural gas.

The breakeven is different when looking at the spot domestic prices of natural gas. In the beginning of 2013 the Hungarian organized natural gas market has been initiated and the opening offers have been around EUR 29,6 /MWh in line with the Western-European spot prices (**CEEGEX, 2013**).

Table 18: Hungarian spot natural gas and lignite prices

	Fuel price (EUR/MWh)
Fuel	
Hungarian lignite	5,88
Spot natural gas	29,35

Source: Valaska, Mátra PP, CEEGEX, Own calculation

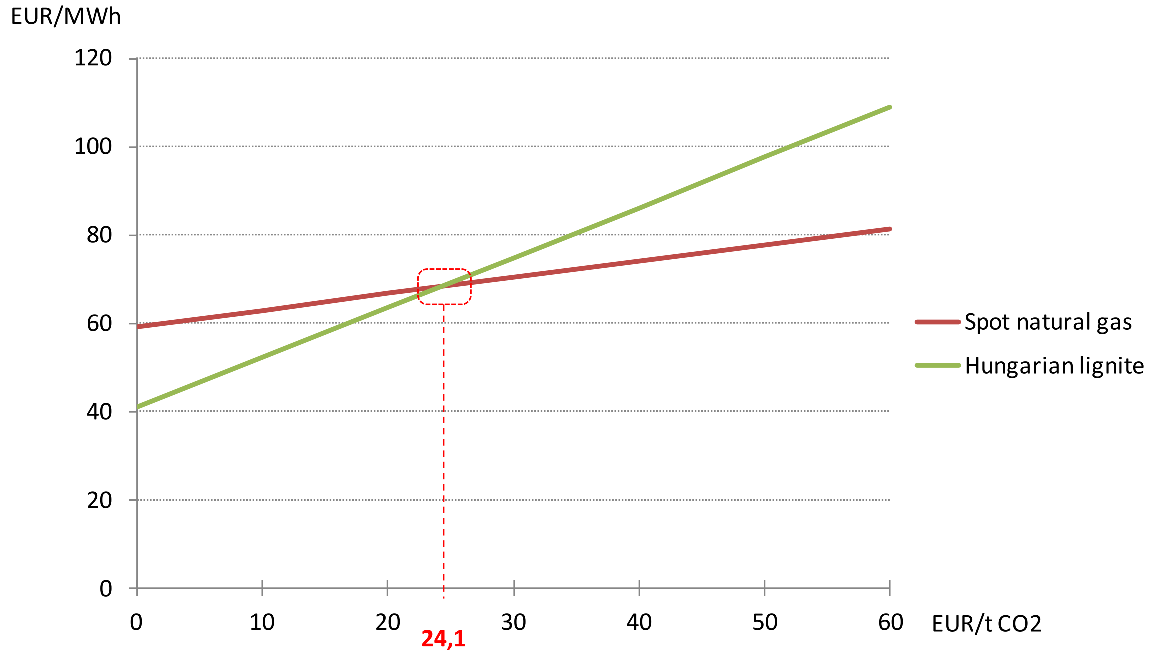
Table 19: Hungarian power prices derived for lignite and spot natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Hungaian lignite	40,83	52,16	63,50	74,83	86,16	97,49	108,82	120,15	131,48	142,81
Spot natural gas	59,29	62,96	66,64	70,31	73,98	77,65	81,32	84,99	88,67	92,34

Source: Own calculation

It can be seen that the breakeven for the cheaper gas is lower compared to the indexed level. The exact breakeven for the cleaner gas shall be at EUR 24,1 /tCO_2.

Figure 33: Hungarian power prices derived for lignite and spot natural gas



Source: Own calculation

It shall be concluded that in the Hungarian case the breakeven for the cleaner gas is in the range of EUR 20-30 /tCO2.

5.3.2.2 Model results: Western Europe

The second analytical assessment focuses on the case of the Western European spot energy markets. Coal and natural gas prices are derived from the Bloomeberg and EEX.

Table 20: Western European Spot fuel prices

	Fuel price (EUR/MWh)
Fuel	
Spot coal	9,35
Spot natural gas	29,35

Source: Bloomberg, EEX, Own calculation

Looking at the modeling results very different conclusion can be derived that has been seen in the case of Hungary resulting from the different breakeven of the cleaner natural gas compared to the dirtier coal.

Table 21: Western-European power prices derived for lignite and natural gas at different emission cost levels

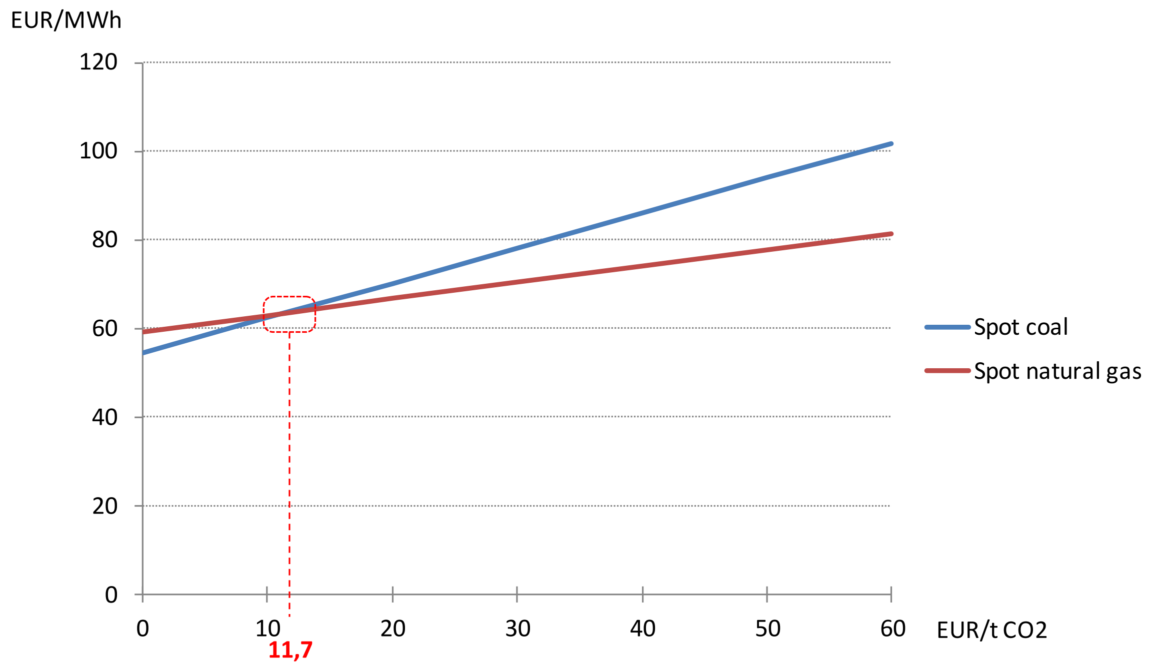
CO2 price (EUR/t)	0	10	20	30	40	50	60
Total PP (EUR/MWh)							
Spot coal	54,36	62,27	70,18	78,09	86,00	93,92	101,83
Spot natural gas	59,29	62,96	66,64	70,31	73,98	77,65	81,32

Source: Own calculation

It is to be seen that the breakeven for natural gas is somewhat above EUR 10 /tCO2 that is less than one third needed for breakeven of the cleaner natural gas compared to the case of Hungary. The exact breakeven is at EUR 11,7 /tCO2.

It is to be noted that resulting from the more expensive coal purchases of the spot market, the competitiveness of gas is increased and the breakeven is below (in the range of EUR 10-20 /tCO2) that of the Hungarian case.

Figure 34: Power price competitiveness comparison of spot traded natural gas and coal as a factor of CO2 price in Europe



Source: Own calculation

From the two graphs assessing the power price competitiveness generated from differently priced fossil fuels it is to be seen that there is a difference in the level of breakeven. In the case of the Hungarian pricing situation around 20 EUR price is necessary for substituting the dirtier coal based generation with natural gas meanwhile, in the Western pricing regime the breakeven is just around 10 EUR.

Although the focus point of this study was developed based on the findings of the regional fuel price differences in the EU the ultimate target of this analysis is to extend the boundaries of the study onto the global level and establish recommendations for future global or multinational emission trade systems.

Fuel price differences in countries that participate in multinational emission trade systems result in a defect which has a negative consequence on least cost carbon emission reduction approach. Because of the fuel price differences the threshold of profitable utilization of carbon intensive fossil fuels is different in different countries or regions and thus the standard CO2 burden results in different carbon emission avoiding strategies of the respective power producers. Based on this, it can be understood that the standard CO2 burden of a multinational emission trade system prescribe different carbon emission avoidance efforts and thus result in reduced efficiency of the emission trade activities for emission reductions.

5.3.2.3 Model results: Other Central and Eastern European (CEE) countries

The third part of the analytical assessment focuses on the case of some of the Central and Eastern European countries and their respective energy markets.

Poland having one of the biggest energy markets in CEE has a paramount role in the region's energy sector development. Further to this, it has a long tradition in coal utilization. Coal prices have been set at the same level that of Hungary as Poland has extensive history in coal mining that allows a cheaper resource than the spot traded and natural gas prices are derived from Bloomberg. Spot coal prices are not available neither on Bloomberg nor on EEX.

Table 22: Polish fuel prices

	Fuel price (EUR/MWh)
Fuel	
Polish coal	5,88
Natural gas	26,58

Source: Bloomberg, Own calculation

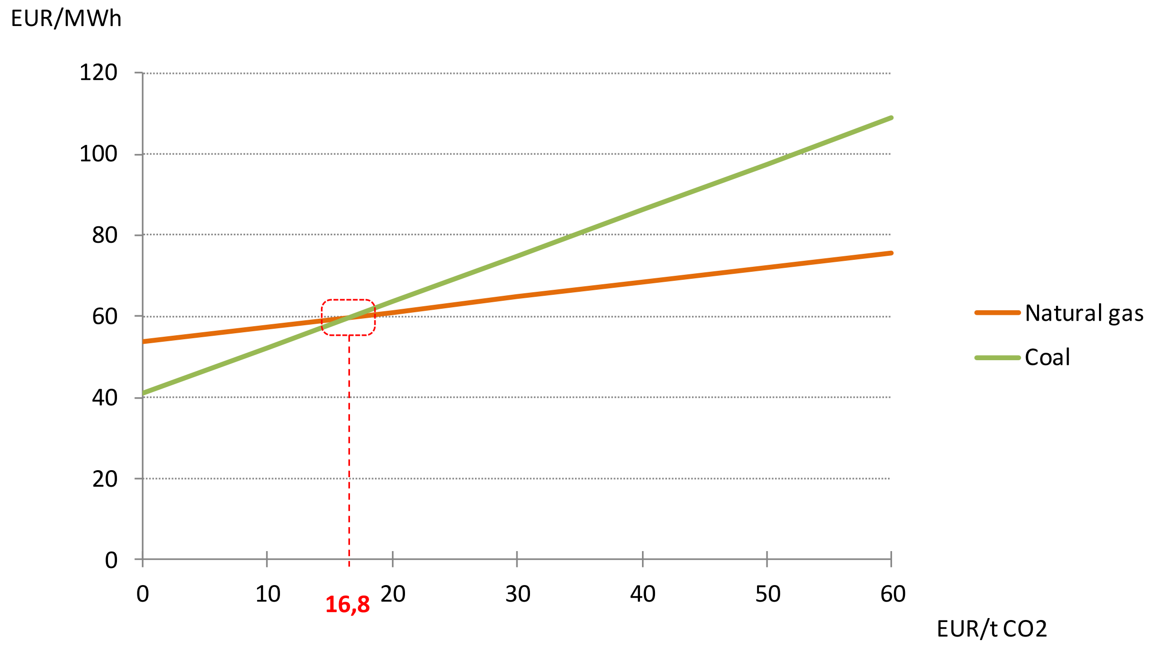
Table 23: Polish power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	40,83	52,16	63,50	74,83	86,16	97,49	108,82	120,15	131,48	142,81
Natural gas	53,70	57,37	61,04	64,71	68,38	72,06	75,73	79,40	83,07	86,74

Source: Own calculation

It can be seen that the breakeven for natural gas is below EUR 20 /tCO2. The exact breakeven happens at EUR 16,8 /tCO2.

Figure 35: Power price competitiveness comparison of Polish coal and natural gas as a factor of CO2 price



Source: Own calculation

It is to be noted that Poland faces less motivation to substitute coal compared to its Western-European counterparties but sees more motivation than Hungary. As discussed in the limitations of the model this conclusion does not lead to the fact that Poland would use less coal than Hungary.

In fact the Polish power mix is more reliant on coal than the Hungarian rooted to the availability of resources and the presence of fitting power plant infrastructure.
That is why Poland should be facing more motivation to substitute its dirtier coal resources than it is experienced in the Western-European countries.

The next CEE country in scope is the Czech Republic and Slovakia analyzed together. Natural gas prices are derived from Bloomberg and coal prices from NWR (New World Resources, 2013).

Table 24: Czech fuel prices

	Fuel price (EUR/MWh)
Fuel	
Coal	7,44
Natural gas	27,63

Source: Bloomberg, NWR

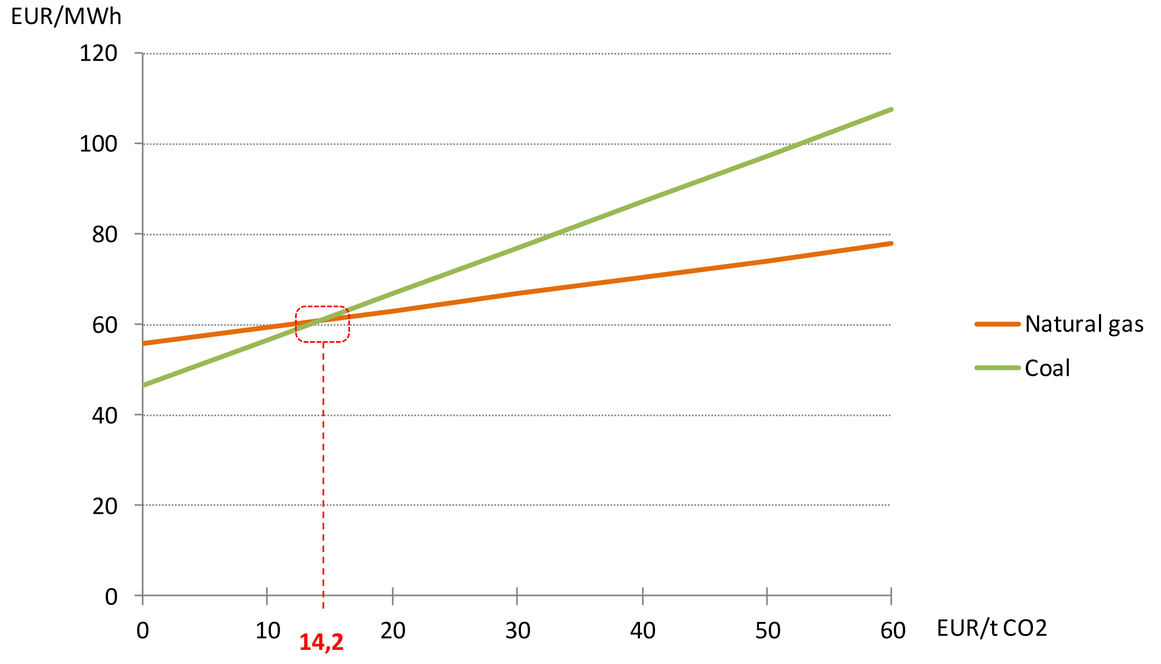
Table 25: Czech power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	46,50	56,70	66,90	77,09	87,29	97,49	107,69	117,89	128,08	138,28
Natural gas	55,82	59,49	63,16	66,83	70,51	74,18	77,85	81,52	85,19	88,86

Source: Own calculation

It can be seen that the breakeven for natural gas is below EUR 20 /tCO2. The exact breakeven happens at EUR 14,2 /tCO2.

Figure 36: Power price competitiveness comparison of Czech coal and natural gas as a factor of CO2 price



Source: Own calculation

The breakeven in the Czech case is somewhat below the Polish case meaning that there is a bit more motivation in the case of the Czech Republic compared to Poland switching from coal to natural gas. Nevertheless, both the Czech Republic and Poland experiences the range for breakeven to be between EUR 10-20 /tCO2.

The next CEE country in focus is Romania. Romanian prices are derived from Eurostat in the case of natural gas and for lignite the Hungarian price level has been used.

Table 26: Romanian fuel prices

	Fuel price (EUR/MWh)
Fuel	
Coal	5,88
Natural gas	19

Source: Own calculation

The favorable natural gas price is thanks to the vast amounts of local natural gas resources available in Romania.

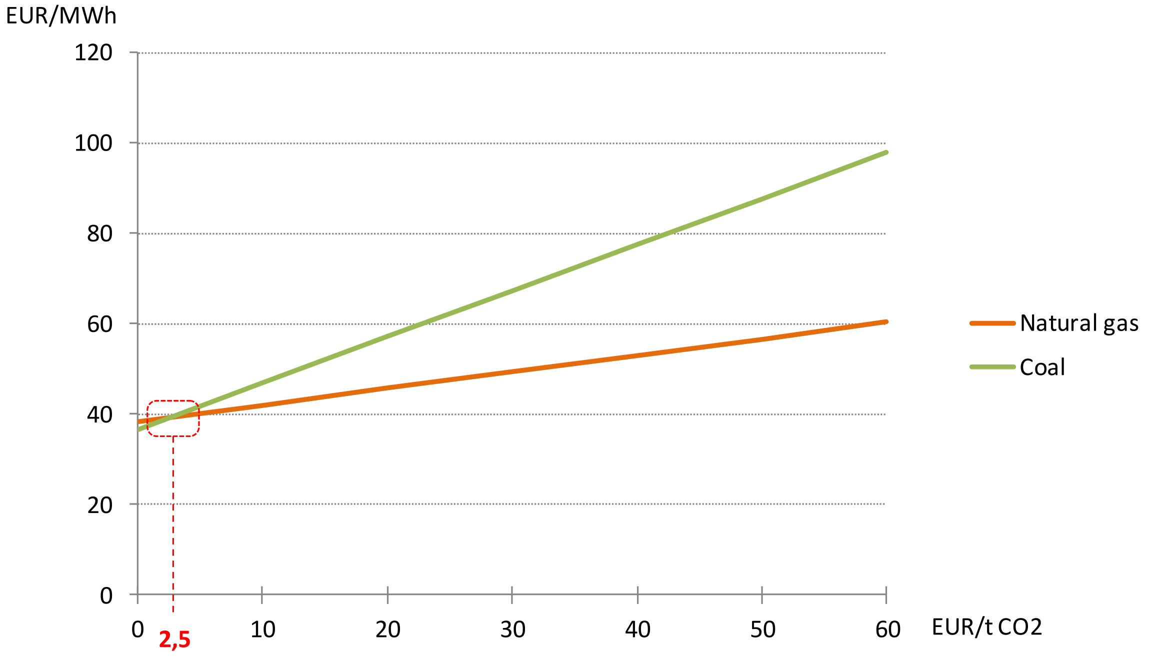
Table 27: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	36,75	46,95	57,15	67,34	77,54	87,74	97,94	108,14	118,33	128,53
Natural gas	38,38	42,06	45,73	49,40	53,07	56,74	60,41	64,09	67,76	71,43

Source: Own calculation

It can be seen that the breakeven for natural gas is much below EUR 10 /tCO2. The exact breakeven happens already at EUR 2,5 /tCO2.

Figure 37: Power price competitiveness comparison of Romanian coal and natural gas as a factor of CO2 price



Source: Own calculation

5.3.2.4 Conclusions: Hungary, Western-Europe and other CEE countries

The analysis highlights that CO2 costs as a factor in the operating expenditures of power generation facilities result in different outcomes for breakeven of the cleaner natural gas compared to the dirtier coal fueled power generation in different geographical locations.

Each country, and being more precise each power plant, faces different fuel price levels in various locations and consequently they experience major differences in the actual power costs incurred through the emission trading scheme.

Further to the above high level conclusion, interestingly Western-Europe, Poland, the Czech Republic, Slovakia, Romania and Hungary can be divided into three separate groups:

1. Romania, having a considerably lower natural gas price than the other countries in scope, experiences the lowest needed price level on emission allowances (EUR ~ 2,5 /tCO2) that allows switching from dirtier coal to cleaner natural gas in power generation.

2. Western-Europe experiences both higher prices on coal and natural gas compared to Romania but the difference is bigger on the side of natural gas. Resultantly, the breakeven for the cleaner natural gas (EUR ~ 10 /tCO2) is above the level of needed emission costs experienced in Romania.

3. CEE countries (Poland, the Czech Republic, Slovakia and Hungary) experience similar trends in coal prices having some discount compared to the Western-European spot markets and thus coal is more competitive even in case of higher CO2 prices and resultantly the breakeven for the cleaner natural gas is between EUR ~ 15-30 / tCO2.

It is to be highlighted that the standard CO2 costs have different effects on countries having different levels of fuel costs in their operating expenditures. It means that a standard CO2 burden in the EU ETS results in diverging price signals to power plant operators. Those countries where natural gas is more expensive and coal is cheaper the breakeven of the cleaner natural gas as an effect of CO2 price is higher compared to those countries where coal is more expensive and natural gas is cheaper.

Short conclusion: regional fuel price differences in multinational emission trade

- **Standard CO2 price of the EU ETS results in diverging effects on the carbon emission abatement efforts of power producers in different countries of the EU as an effect of different cost structures of power generators, especially in case of fuel purchasing expenditures**

- **The standard CO2 cost burden may have contra productive effects in decarbonization of the power generation sector as the power plants cannot change geographical locations because of cost optimization strategies**
- **The least cost GHG mitigation in ETS is hampered by the geographic limitation of the power generation sector which needed alternative solutions to achieve efficient CO2 emission reduction**

5.3.3 The global perspective on fuel price differences and the standard CO2 cost

Based on the findings of the analysis focusing on the ETS it can be secured that similar outcomes are to be seen in the case of a global emission trading scheme having a standard CO2 cost burden prescribed to the power generation sector. Hence, major emitters and fuel exporter/imports are further analyzed to prove this hypothesis.

5.3.3.1 Model results: Australia

Australia's fuel prices have been obtained from DomGas Alliance, Annual Report 2012.

Table 28: Australian fuel prices

	Fuel price (EUR/MWh)
Fuel	
Coal	5
Natural gas	24

Source: DomGas, Own calculation

Australia has both coal and natural gas resources available although with different regional distribution because of the size of the continent (**AuGov, 2012**).

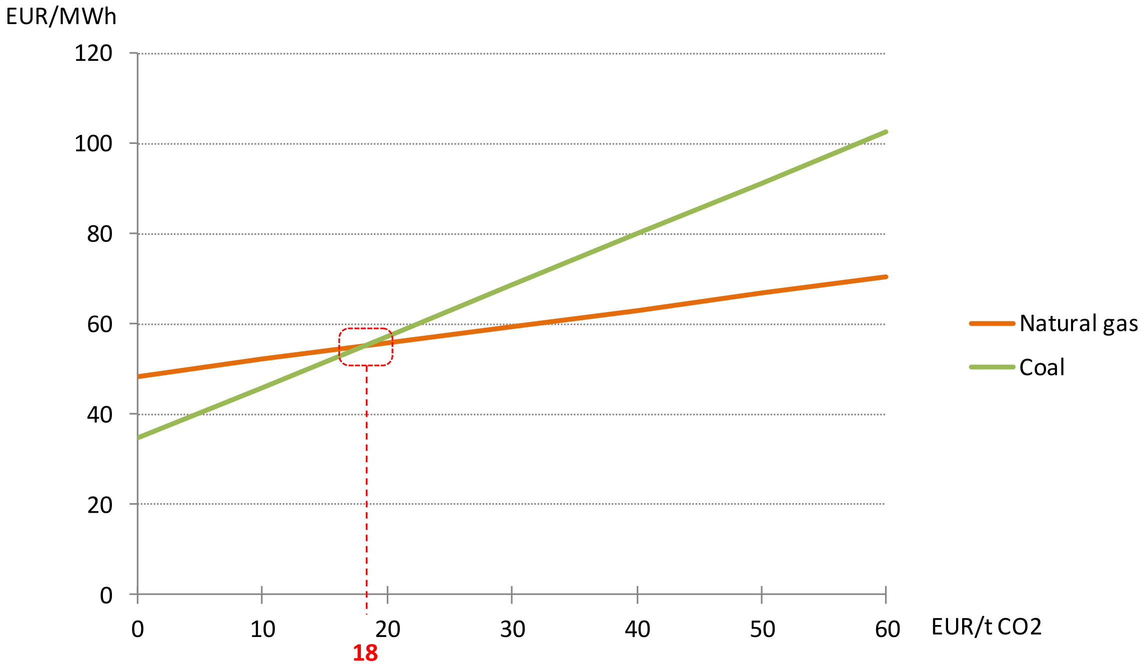
Table 29: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	34,72	46,05	57,38	68,72	80,05	91,38	102,71	114,04	125,37	136,70
Natural gas	48,48	52,16	55,83	59,50	63,17	66,84	70,52	74,19	77,86	81,53

Source: Own calculation

It can be seen that the breakeven for natural gas is below EUR 20 /tCO2. The breakeven happens at EUR 18 /tCO2.

Figure 38: Power price competitiveness comparison of Australian coal and natural gas as a factor of CO2 price



Source: Own calculation

5.3.3.2 Model results: Russia

Russian fuel prices have been obtained from Bloomberg.

Table 30: Russian fuel prices

	Fuel price (EUR/MWh)
Fuel	
Coal	7
Natural gas	21,74

Source: Bloomberg, Own calculation

Russia has both coal and natural gas resources available although with different regional distribution because of the size of the country.

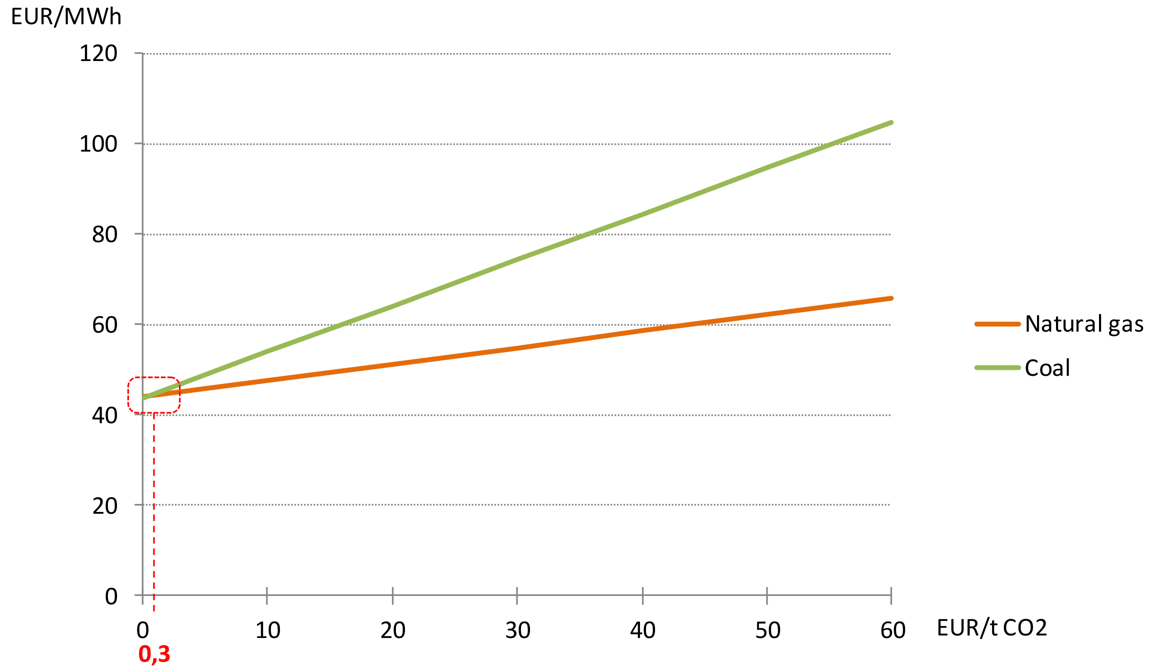
Table 31: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	43,75	53,95	64,15	74,34	84,54	94,74	104,94	115,14	125,33	135,53
Natural gas	43,92	47,59	51,26	54,93	58,61	62,28	65,95	69,62	73,29	76,96

Source: Own calculation

It can be seen that the breakeven for natural gas is close to EUR 0 /tCO2. The breakeven happens under 1 EUR /tCO2 at 0,3 EUR /tCO2.

Figure 39: Power price competitiveness comparison of Russian coal and natural gas as a factor of CO2 price



Source: Own calculation

5.3.3.3 Model results: USA

US fuel prices have been obtained from Bloomberg and FERC.

Table 32: US fuel prices

	Fuel price (EUR/MWh)
Fuel	
Coal	6,27
Natural gas	8,17

Source: Bloomberg, FERC

US have both coal and natural gas resources available although with different regional distribution because of the size of the country.

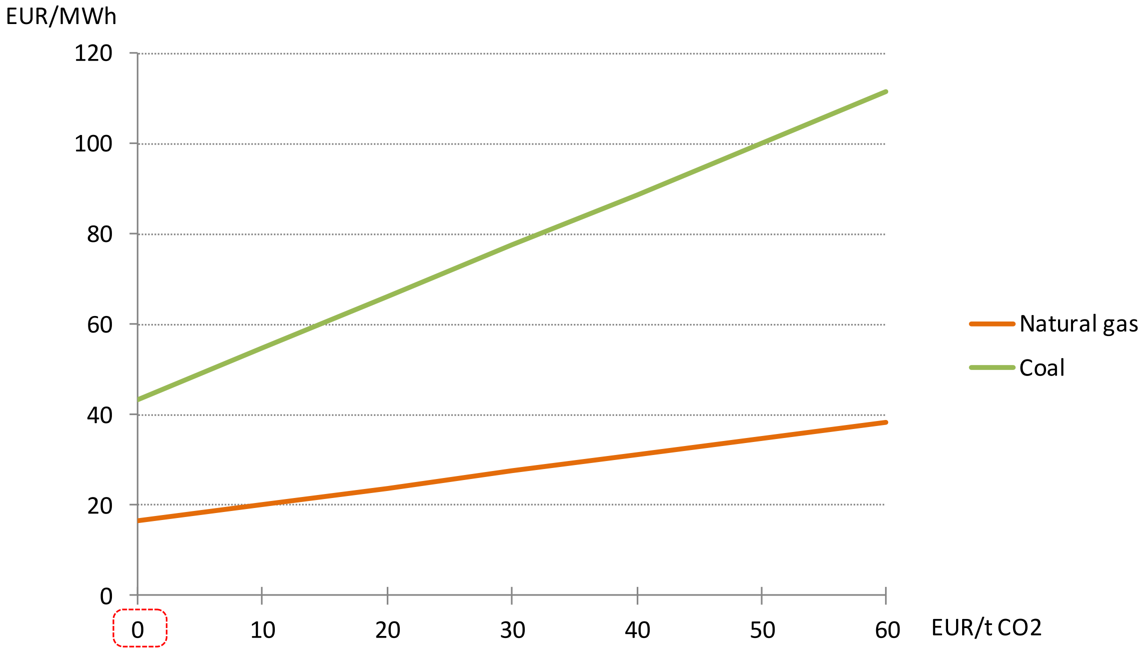
Table 33: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	43,54	54,87	66,20	77,53	88,87	100,20	111,53	122,86	134,19	145,52
Natural gas	16,51	20,18	23,85	27,52	31,19	34,86	38,54	42,21	45,88	49,55

Source: Own calculation

It can be seen that the breakeven for natural gas happens without any emission costs prescribed.

Figure 40: Power price competitiveness comparison of US coal and natural gas as a factor of CO2 price



Source: Own calculation

USA is the first country in the analysis where natural gas is more competitive to coal without any cost prescribed on greenhouse gas emissions. It is not a secret that the booming shale gas industry has revolutionized the energy sector of the US sourcing a rather cheap and cleaner option compared to the traditional coal, natural gas and crude oil markets.

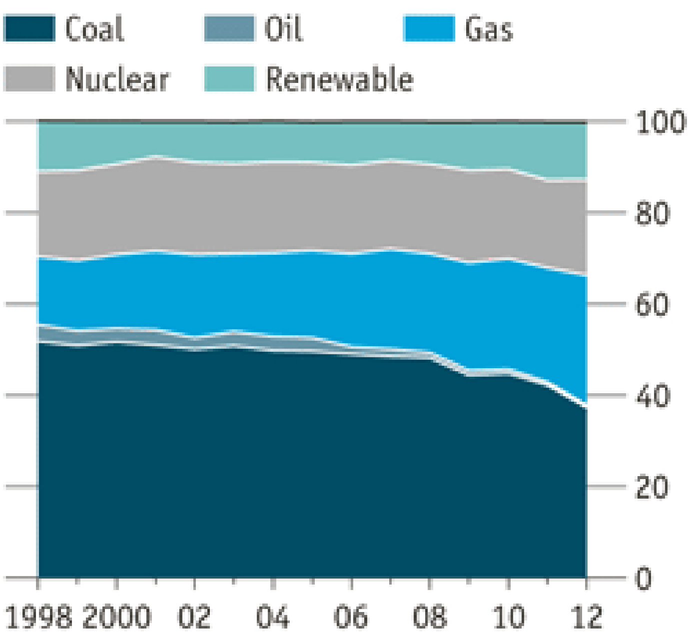
This breakthrough is visible on the following map detailing global LNG prices (liquefied natural gas).

Figure 41: LNG landed prices - 2013 Estimate (USD/MMBtu)

Source: FERC

Thanks to the increased competitiveness of shale gas in the US the country experienced a rare transformation in its electricity mix resulting in decreasing importance of coal compared to other fuel sources. It means the transformation of the power sector is happening without any carbon emission costs prescribed to power companies.

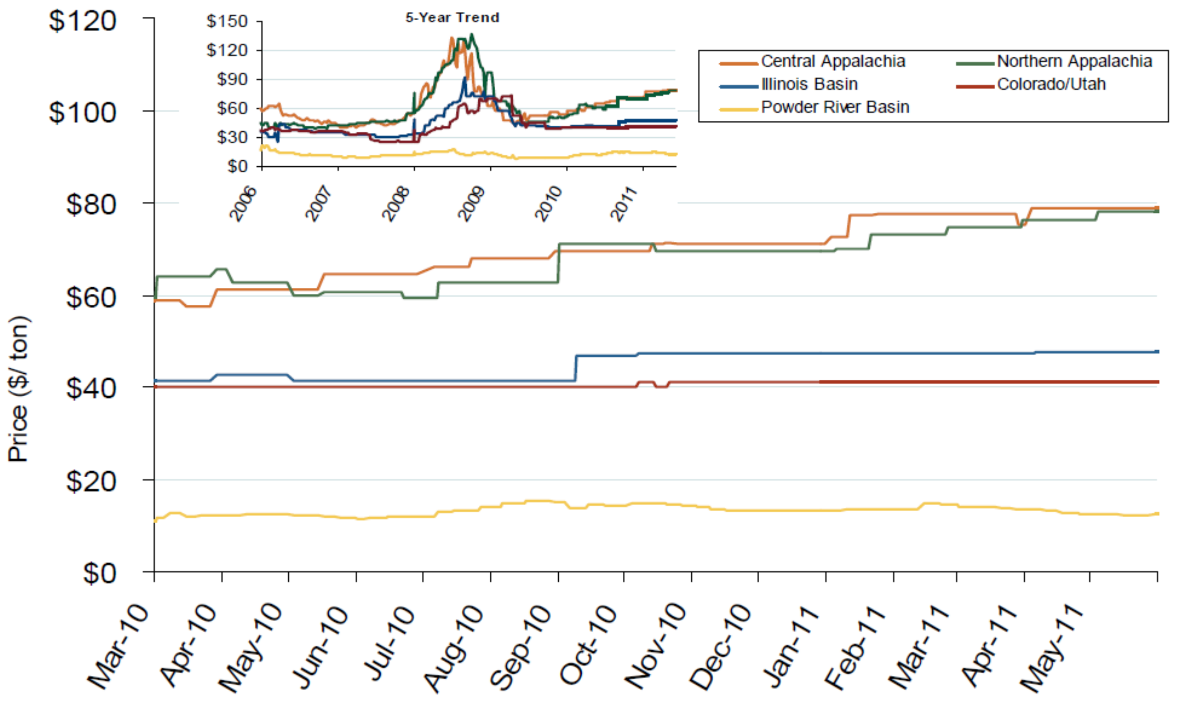
Figure 42: Changing US power generation mix



Source: Economist

It is to be noted that because of the size of the country there are different price levels experienced in the coal market.

Figure 43: US regional coal spot prices



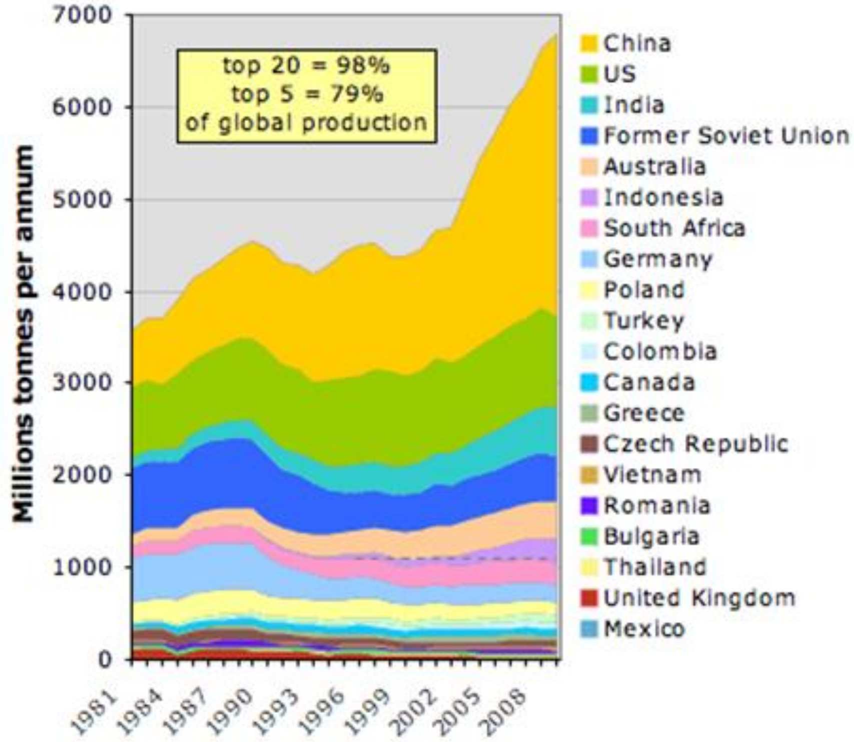
Source: FERC

Nevertheless taking any of the price levels the situation does not change in respect to breakeven of the cleaner gas as a result of the low natural gas prices experienced.

5.3.3.4 Model results: China

China is an interesting country both in terms of available resources and prices. China has both coal and natural gas reserves available but there are different types of problems in its energy sector. On the one hand China is one of the biggest coal producers around the world nevertheless, and on the other hand it needs further coal imports to fuel the economy.

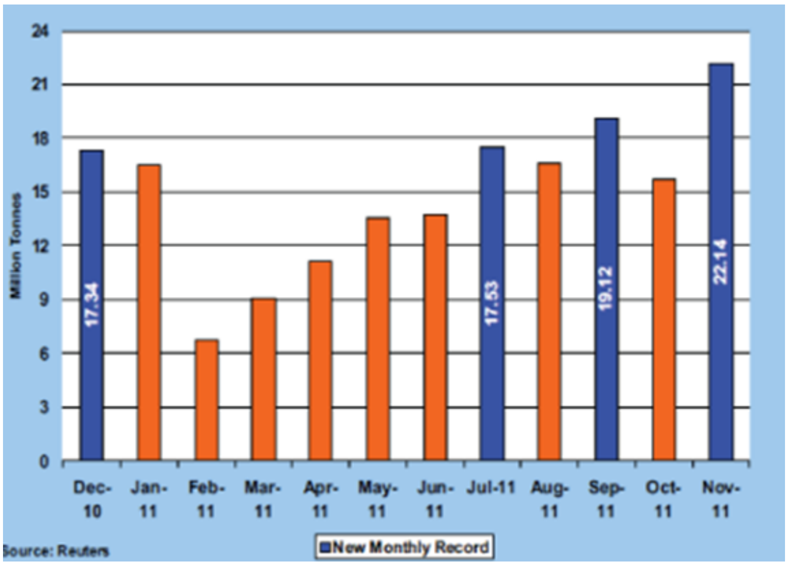
Figure 44: Top 20 coal producers



Source: Business Insider

Although seeing one of the biggest production volumes China is facing record high demand for additional coal imports in the country.

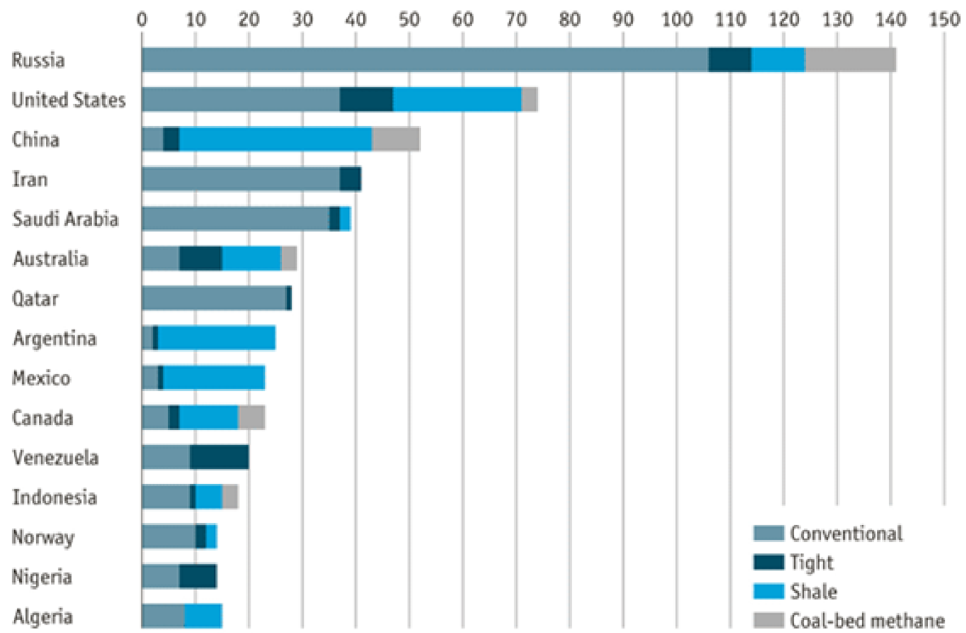
Figure 45: Monthly Chinese coal imports



Source: Daniels Trading

China has natural gas reserves but mostly in unconventional resources that make accessing these resources more expensive.

Figure 46: Recoverable natural gas reserves, tcm (2011)



Source: IEA

Based on the above it can be noted that although China has available resources it needs to rely on magnitudes of fuel imports. This concludes another problem with the energy industry that there are huge discrepancies in pricing regimes. Domestic supplies are cheap and the industry needs the low price levels to fuel the Chinese economy. Hence fuel imports need subsidies to level off the differences in the prices of domestic and imported fuels.

Another problem of the analysis is the availability of price indications. There is a lack of adequate price indications from fuels available domestically in China. For the imported fuels the global average prices are good indications nevertheless taking these prices would imply a fake result for the power generation sector's emission cost assessment. Because of this, the two ends of the price extremity are to be identified and a best estimate derived from those. For the sake of a best guess assessment of the economics of domestic coal and natural gas the lowest prices have been selected from the previous assessments and further discounted with 25 % because of the low wage levels and potential discounts available in the country.

The low fuel cost scenario is described in the following:

Table 34: Chinese fuel costs (low scenario)

	Fuel price (EUR/MWh)
Fuel	
Coal	3,75
Natural gas	14,25

Source: Own calculation

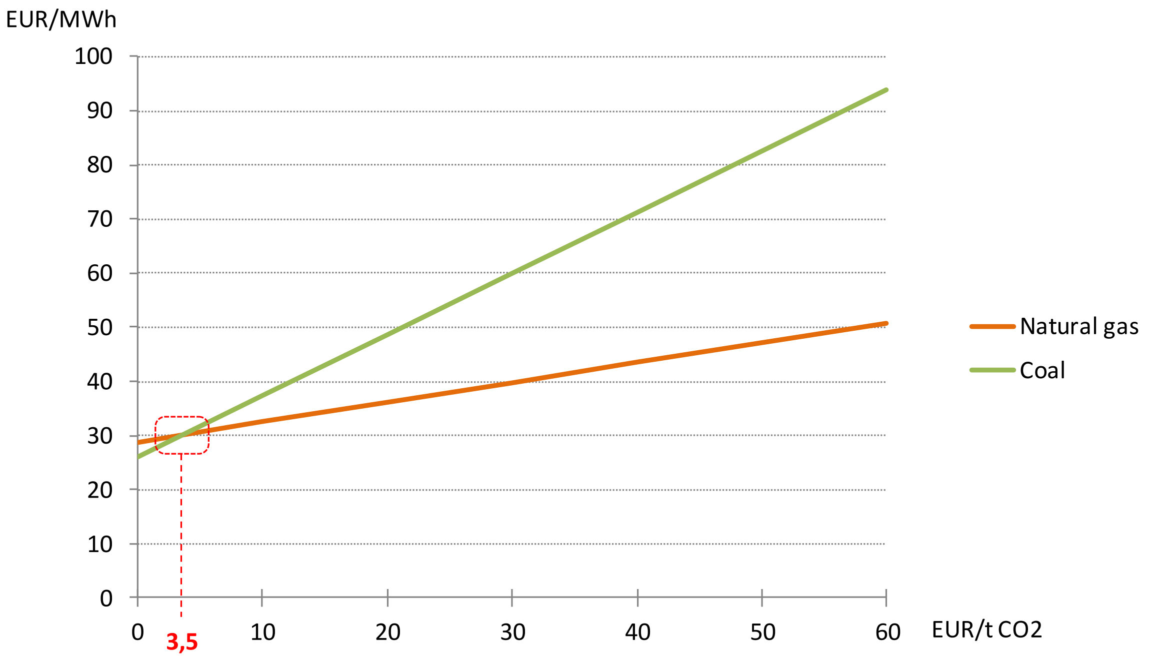
Table 35: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	26,04	37,37	48,70	60,03	71,37	82,70	94,03	105,36	116,69	128,02
Natural gas	28,79	32,46	36,13	39,80	43,47	47,15	50,82	54,49	58,16	61,83

Source: Own calculation

It can be seen that the breakeven for natural gas is below EUR 10 /tCO2. The exact breakeven is at EUR 3,5 /tCO2.

Figure 47: Power price competitiveness comparison of Chinese coal and natural gas as a factor of CO2 price (low scenario)



Source: Own calculation

The high fuel cost scenario is described in the following:

Table 36: Chinese fuel costs (high scenario)

	Fuel price (EUR/MWh)
Fuel	
Coal	9,35
Natural gas	34

Source: Bloomberg, Own calculation

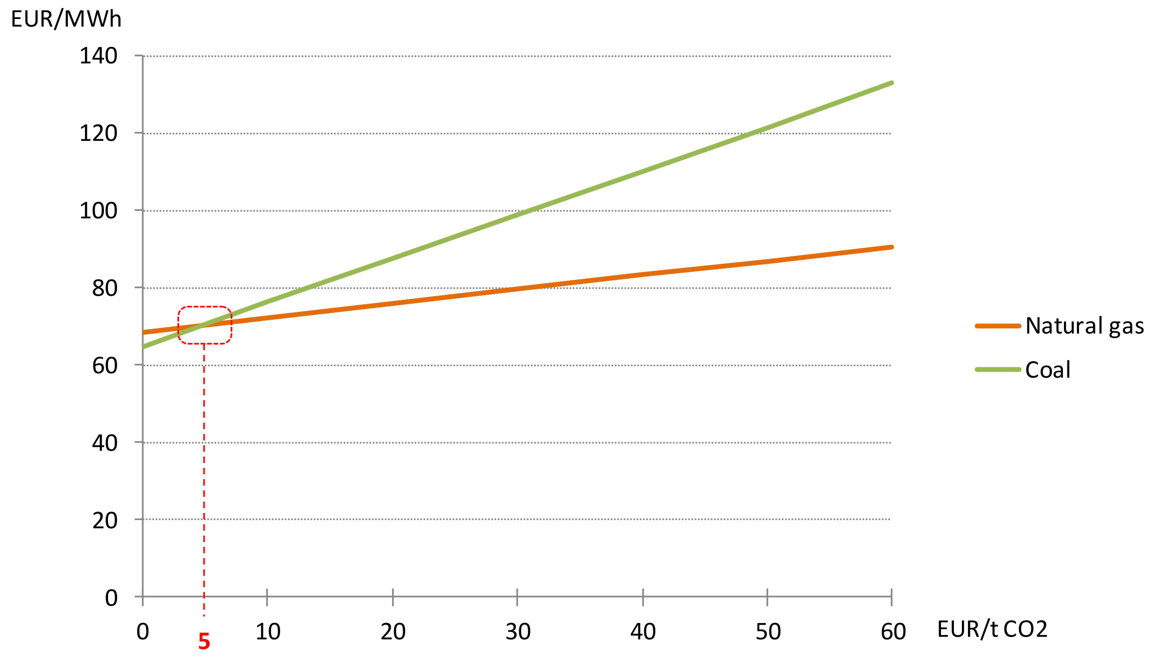
Table 37: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	64,93	76,26	87,59	98,92	110,25	121,59	132,92	144,25	155,58	166,91
Natural gas	68,69	72,36	76,03	79,70	83,37	87,05	90,72	94,39	98,06	101,73

Source: Own calculation

It can be seen that the breakeven for natural gas is below EUR 10 /tCO2. The exact breakeven is at EUR 5 /tCO2.

Figure 48: Power price competitiveness comparison of Chinese coal and natural gas as a factor of CO2 price (high scenario)



Source: Own calculation

Based on my assumption neither the low nor the high scenario provided a sound outcome for the assessment. In my view coal is rather priced low and natural gas rather high because of the quality, convenience and social support related fundamentals.

Based on the above a best guess scenario was developed:

Table 38: Chinese fuel costs (best estimate)

	Fuel price (EUR/MWh)
Fuel	
Coal	5
Natural gas	25

Source: Own calculation

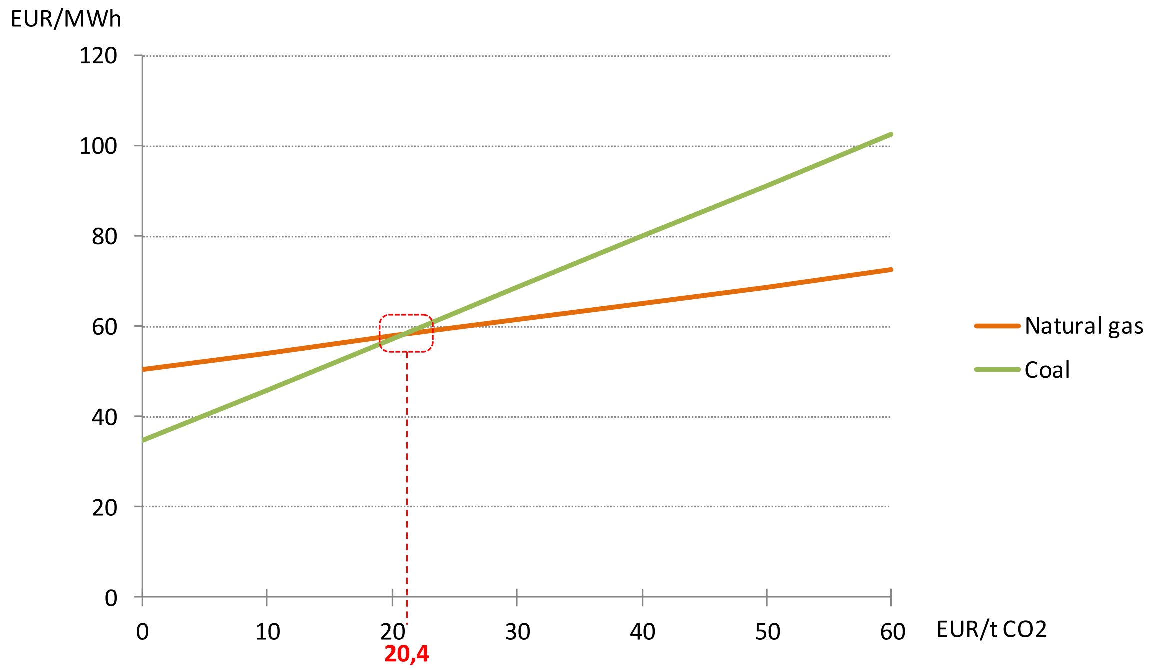
Table 39: Power prices derived for coal and natural gas at different emission cost levels

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	34,72	46,05	57,38	68,72	80,05	91,38	102,71	114,04	125,37	136,70
Natural gas	50,51	54,18	57,85	61,52	65,19	68,86	72,54	76,21	79,88	83,55

Source: Own calculation

It can be seen that the breakeven for natural gas is at EUR 20,4 /tCO2.

Figure 49: Power price competitiveness comparison of Chinese coal and natural gas as a factor of CO2 price (best estimate scenario)



Source: Own calculation

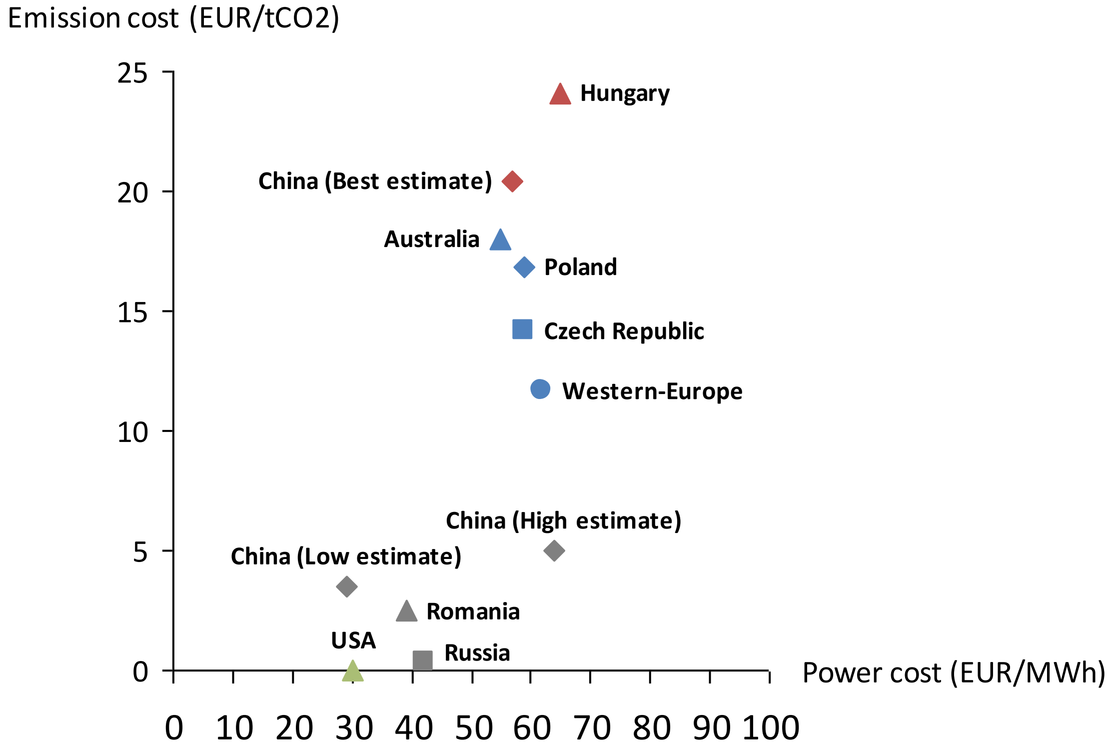
5.3.3.5 Conclusions: Results of the fuel price differences on power generation assets in the global perspective

A few conclusions are evident in respect to the fuel price differences assessment presented above:

- CO2 costs have a major effect on power prices;
- differences in fuel prices heavily affect power prices and the effects of the standard CO2 burden;
- a standard CO2 burden has diverging effects on power producers resulting in contra productive outcomes, such as that Hungarian power producers are less motivated to switch from coal to gas compared to their Western-European counterparties;
- each of the analyzed countries have different fuel price levels experienced in power generation sector and resultantly each country experiences different levels of breakeven of the cleaner natural gas compared to the dirtier coal;
- low natural gas prices result in deterioration of coal based power generation even if there is no CO2 burden on the generators;
- just the US, out of the analyzed countries, have such cheap natural gas resources that no CO2 burden is necessary to motivate power plants to phase out coal against natural gas.

The following graph visualizes the differences in the breakeven of natural gas compared to dirtier coal generation as a factor of different emission cost levels.

Figure 50: Breakeven of natural gas against coal based power generation on different emission cost levels



Source: Own assessment

The ETS is a novel system that has established a quantum leap in the environmental protection strategies of the human society. The ETS put a standard burden on each of the emitters and based on this established a market based instrument for mitigating greenhouse gas emissions.

This approach is a sound tool in a competitive market context where the capital is able to select the location of its activities based on the costs and benefits it may experience. It means any industrial producer is capable of identifying the best fitting locations for its production in connection to the foreseen cost. Most of the industries select their locations based on a calculation of forecasted profits and losses. In the case of productive industries a standard CO2 cost is adequate to motivate the producers to mitigate their emissions and as a standard cost is prescribed the companies are able to move to those places where other cost factors of production are more beneficial to them.

The case is slightly different for the power generation sector as power can only be transferred with considerable losses on bigger distances. Another problem with power export-import is the availability of adequate cross border transmission capacities. Resultantly, power production is not a sector that can easily relocate to rationalize its costs but need to have generation capacities in vicinity of the consumers. In such a sector the standard CO2 burden with diverging fuel costs in the cost structures of different producers prescribe unfair and in some cases contra productive effects. As a result, the effect of the ETS on the European power sector is not straightforward. Hence, countries with more developed infrastructure are even more motivated to innovation compared to those having outdated infrastructure in place.

The ETS has introduced regulation to a sector that is liberalized as a result of the 3rd energy package of the EU and has done so neglecting local, national, regional and multinational peculiarities of the sector. The same problem shall inevitably evolve in the case of any future multinational or global emission trade systems that neglect the specialties of the power generation sector.

Short conclusion: fuel price differences in the global perspective

- **Standard CO2 costs and fuel price differences result in diverging effects on power producers in the global perspective similarly to the case described in the European dimension**
- **Only the USA experiences such beneficial tendencies that allows that power generators switch from the dirtier coal to the cleaner natural gas without any CO2 costs prescribed to producers**

In the following the GIS is described as a potential tool to balance out the negative effects of regional fuel price differences and a standard CO2 burden of the power generation sector.

6 THE CASE OF THE HUNGARIAN GREEN INVESTMENT SCHEME

Hungary has accessed the UNFCCC and the Kyoto Protocol to promote sustainable development and as party to the Protocol has taken on a legally binding obligation to curb greenhouse gas emissions by 6% (**NES, 2008**). The ex-socialist Central and Eastern European countries, including Hungary, became the biggest possessors of AAUs thanks to the economy transition in the end of the 20th century.

The baseline for Hungary was set to the average of 1985-87 instead of the general baseline of the parties (1990) (**NES, 2008**). The reason for it was that Hungary was an economy in transition and because of the political and economy changes in the end of the 80s and beginning of the 90s it experienced an enormous drop in industrial output and subsequently in greenhouse gas emissions. It means that the effects of the economic transition are not taken into account when the emission reduction targets are to be concluded. Hungary experienced a drop in greenhouse gas emission that were the effect of political and economic changes and thus were not achieved through purposeful emission reduction interventions. It may be and has been questioned that such emission reductions can be accounted for under the Kyoto scheme.

AAU trade has been widely debated and claimed to be “hot air” meaning that there is no actual emission reduction effort related to them. Because of this dispute the trade of AAU has only very slowly incepted which had a major breakthrough thanks to the introduction of the system of GIS. The GIS provides a framework of climate change mitigation measures to be implemented in countries having AAU surpluses to be greened out post AAU sales. Based on this framework the debated hot air can be greened out through targeted energy efficiency, renewable energy, and general sustainability type of investments.

Hungary was one of the first countries to initiate IET and was able to sell AAU to Japan, Spain and Belgium with the help of GIS. The actual trade activities have been started in 2008 and through a series of negotiations about 11-12 million AAUs have been sold. The government targeted the sales of around 90 million AAUs as maximum. The Hungarian Climate Change Strategy ensures that all prospective revenues will be spent solely for climate change mitigation activities.

Hungary targets hard greening interventions, which means each intervention has to have a measurable greenhouse gas emission reduction effect that is post hoc auditable and verifiable. Hard greening also entails the following:

- maximization of CO_2 emission reduction per unit of support (maximizing the efficiency of the disbursement);
- ensures technical feasibility of an intervention;
- differentiates the rate of support based on efficiency aspects;
- avoids competition with existing support schemes;
- allows demonstration and marketing through visibility;
- takes into consideration all the applicable EU regulations and international best practices;
- secures follow-up monitoring and verification.

Based on this approach Hungary could initiate its GIS in 2009 and start disbursing the incomes generated through the successful International Emission Trade activities.

6.1 Background of the Hungarian IET and GIS

The basis of International Emission Trade in Hungary is defined through two main legislative documents:

• 2007 No. LX. Law (Implementing the United Nations Framework Convention on Climate Change and Kyoto Protocol) and

• 323/2007. (XII.11) Government Decree. (implementation of 2007 No. LX. Law United Nations Framework Convention on Climate Change and its Kyoto Protocol).

The rules for international trade as prescribed by the Law:

2. § 7 International emissions trading is a procedure falling under the flexibility mechanisms of the Protocol;

5.§ (1)The transfer of the units in the registry is managed by the national environmental authority;

5.§ (3) Prerequisite of the transfer is the full inventory of the AAUs in the national registry;

9.§ (5) The allowances can be transferred without any restriction into the subsequent commitment period;
10.§ (2) The Minister of the Environment is entitled to trade with the units and establish the Green Investment Scheme (**MoEW, 2007**).

323/2007 Decree provides the rules of trading with AAU allowances. The assigned amount units can be sold with respect to the following conditions:
§ 20 (1) The Minister may initiate IET taking into account the following:

- Hungarian Climate Change Strategy and Program
- National Emission Inventory
- National Emission Inventory forecasts
- The degree of fulfillment of Kyoto commitments
- International emissions trading mechanisms and price conditions
- The implementation of cost-effective emission reduction principles.

20 § (2) the agreement can only be made with confirmation of the Minister of Finance
21 § (2), the units are only to be transferred after the purchase price has been transferred
22 § (1) based on § 20 the incomes generated are distributed through a Green Investment that provide further financing to green interventions through a national application system (**MoEW, 2007**).

Based on the above two legislations it is ensured that the sales of emission allowances can only be decided on the highest ministerial level covered by the Ministry of Environment and confirmed by the Minister of Finance (**MoEW, 2007**). Since that time, the Ministry of Environment's Climate Unit has been transferred to the Ministry of Development and consequently administration and approval of the system has been transferred to the Minister of Development.
Involvement of the policy and decision makers ensures the highest security for Hungary in achieving the highest environmental and economy revenues achieved through the IET. Further to this the legislation prescribes that entire revenues have to be disbursed through national funding schemes to further environmental protection interventions.

6.1.1 *Advantages of an IET backed up with GIS in contrast to project based flexible mechanisms of the Protocol*

The novelty of the GIS is the flexibility in identification and execution of the proposed greenhouse gas emission reduction interventions. The Clean Development Mechanism and the Joint Implementation projects are standardized which may result in bureaucratized and slow process of administration, acceptance, implementation, execution, etc. (**MoEW, 2008**). One of the most important benefits of IET backed up with the GIS is that it is not as bureaucratic as the JI or CDM and the intervention/s are defined and agreed on between the two parties namely, the seller –in this case Hungary- and the buyer. On the other hand, this also implies the biggest risk in respect to emission trade, namely there are no standard safeguards established to ensure successful implementation of the program. Hence, it is important to note that in the case of such transaction the most important aspects of for financers is the security which ensures that the paid cash, is transformed to real and additional emission savings. In the case of Hungary the most important step to safeguard the transactions was the establishment of the appropriate legal background and institutional set up of the GIS as described above.

Main characteristics of the expectations of buyers including Canada, UK, Spain, Italy, the Netherlands, and Japan:
Policy strategy: hard greening (CO2 reduction to be accurately measurable)
Types of interventions: project-based
Type of planning: top-down and bottom-up (announced by the government but formed on the basis of demand)
Beneficiaries: potentially each type of energy consumers and producers
Distribution method: grant
Time horizon: mainly shorter timeframe interventions, preferably maximum one year long implementation (**Feiler, pers. comm.**).

Main characteristics of the types of interventions of project based hard greening interventions have been also thoroughly discussed with potential buyers based on which the main targets have been defined as follows. Special focus shall be given to those interventions which require external funding to be financially viable on the large scale but have real emission reduction potential, e.g.: panel buildings; family homes; heat from renewable energy; small scale local district heating; heat insulation (**Feiler, pers. comm.**).

6.2 Achievements of the Hungarian GIS 2009-2011

As stated by MoEW the total incomes generated through IET transactions reached the level of HUF 36 billion which prescribes around EUR 130 million applicable to the funding of the national Green Investment Scheme (**KVVM, 2010**). The incomes have been generated through three major transactions realized with Spain, Belgium and Japan. The total amount of sold AAUs was around 10 million tons meaning the price was somewhat above 10 Eur/ton. The news indicated a price level of around 14 EUR/AAU (**PointCarbon, 2009**).

Further sales were planned till the end of 2012 without a forecasted value of the potential deals. No information has been disclosed available regarding to their achievement till 2013. With respect to the financial value deterioration of Kyoto credits potentially the falling prices were not adequate to address further national level interventions and that is why there were no other successful transactions realized in 2012.

With respect to the achieved prices it can be concluded that it was in the "ballpark". There have been rumors in Hungary around the confidentiality of the sales prices and fears have been raised that these deals have generated losses to the country.

Based on the available information the price level of AAUs can be considered well above average market expectations, taking into consideration that the prices have been fluctuating in the emission market in general. The present analysis focuses on the utilization of the incomes generated through IET and not on the valuation of the emission units.

The following information has been compiled based on the Annual Report 2011 of the Hungarian Green Investment Scheme (**GIS, 2012**) and own analyses. The useful lifetime of each intervention has been assessed separately and the average potential CO2 emission reductions have been computed to the entire utilization period of the investment in scope.

Seven parallel subsidies have been launched up since 2009:

1. GIS Block houses phase 1
2. GIS Block houses phase 2
3. GIS Climate friendly homes
4. GIS Energy efficient home appliances
5. GIS Light bulbs
6. GIS Our home
7. GIS Solar collectors

The results of each of the applications are as follows:

GIS Block houses phase 1:

Scope of the interventions covered door and window changes, insulation, and building engineering improvements.

- 950 successful applications received
- HUF 14,6 billion total funding awarded
- Nearly 48 000 flats in scope
- 34 265 tCO_2/year emission reduction
- Monitoring for 5 years
- Useful lifetime: guarantied 20; best guess 40; potential maximum 60 year

(Source: GIS, Own calculation)

Average key performance indicators (KPIs) for the performance of 40 subsequent years:

- Total CO_2 saving of around 857 000 ton
- Average 29 tCO_2 saving per flat
- Average EUR 36/tCO_2 to be saved

GIS Block houses phase 2:

Scope of the interventions covered door and window changes; insulation; building engineering improvements such as heating, elevators, ventilation; renewable energy utilization; shading; passive solar heating.

- 336 successful applications received
- HUF 16,4 billion total funding awarded
- Nearly 30 000 flats in scope
- 44 041 tCO_2/year emission reduction
- Useful lifetime: guarantied 20; best guess 40; potential maximum 60 year

(Source: GIS, Own calculation)

Average key performance indicators (KPIs) for the performance of 25 subsequent years:

- Total CO_2 saving of around 1 101 000 ton
- Average 59 tCO_2 saving per flat
- Average EUR 31/tCO_2 to be saved

GIS Climate friendly homes:

- 1 191 successful applications received
- HUF 2 billion total funding awarded
- Nearly 2 000 flats in scope
- 5 128 tCO_2/year emission reduction
- Useful lifetime: guarantied 20; best guess 40; potential maximum 60 year

(Source: GIS, Own calculation)

Scope of the interventions covered any energy efficiency interventions, and renovations of old family houses and the building of new highly efficient family homes.

Average key performance indicators (KPIs) for the performance of 40 subsequent years:

- Total CO_2 saving of around 205 000 ton
- Average 103 tCO_2 saving per flat
- Average EUR 33/tCO_2 to be saved

GIS Energy efficient home appliances:

- 195 successful applications received
- HUF 1 billion total funding awarded
- About 11 700 flats in scope
- 3 830 tCO_2/year emission reduction
- Useful lifetime: 15 years

(Source: GIS, Own calculation)

Scope of the interventions focused to underprivileged social groups and covered change of old refrigerators and washing machines to 'A' or higher energy efficiency performance.

Average key performance indicators (KPIs) for the performance of 15 subsequent years:

- Total CO_2 saving of around 57 450 ton
- Average 5 tCO_2 saving per flat
- Average EUR 58/tCO_2 to be saved

GIS Light bulbs:

- 257 successful applications received
- HUF 0,45 billion total funding awarded
- About 20 300 flats in scope
- 17 681 tCO_2/year emission reduction
- Useful lifetime: 5 years

(Source: GIS, Own calculation)

Scope of the interventions focused to underprivileged social groups and covered change of old light bulbs to new efficient ones. Further to this the program covered the collection and the disposal of the hazardous wastes of old bulbs.

Average key performance indicators (KPIs) for the performance of 5 subsequent years:

- Total CO_2 saving of around 88 400 ton
- Average 4,4 tCO_2 saving per flat
- Average EUR 17/tCO_2 to be saved

GIS Our home:

- 422 successful applications received
- HUF 1,56 billion total funding awarded
- 458 flats in scope
- 11 500 tCO_2/year emission reduction
- Useful lifetime: 25 years

(Source: GIS, Own calculation)

Scope of the interventions focused to energy efficiency interventions and renewable energy investments in family houses.

Average key performance indicators (KPIs) for the performance of 25 subsequent years:

- Total CO_2 saving of around 287 500 ton
- Average 628 tCO_2 saving per flat
- Average EUR 18/tCO_2 to be saved

GIS Solar collectors (processing in progress) (**Beregszászi, pers. comm.**)

- 2195 applications received (support decisions unavailable)
- HUF 1,53 billion total funding requested

Scope of the interventions focused to solar investments for heating and hot water production. Solar power generation was out of scope.

6.3 Key Performance Indicators of the Hungarian GIS

The GIS provides a tool for national level interventions and target those stakeholders which are primarily not involved in the emission reduction efforts of the European Union, namely the residential and public sectors. Apart from this, the GIS supports those activities which are out of the scope of the Kyoto Protocol or the EU ETS, especially demand side management (insulation, temperature control, efficient electric appliances, etc.). It means these subsidies are inevitable to extend the scope of the multinational emission trading systems and further GHG emission mitigation on the global level. Further to these the GIS comprises a wider set of beneficial outcomes apart from the GHG emissions. Residential energy consumers may reduce their energy needs through the assistance of the GIS and thus reduce their overall energy costs resulting in social level benefits to the national economy.

Short conclusion:

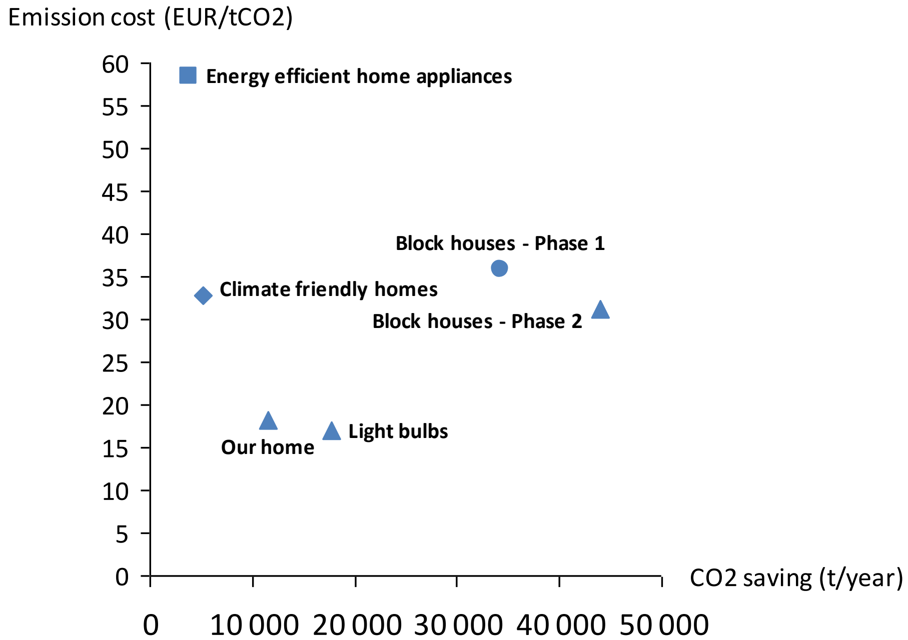
Three of the main advantages of the GIS compared to Kyoto's project based mechanisms are that

1. **it establishes national level interventions with economies of scale,**
2. **it brings immediate social benefits to the citizens further to the valuable national level GHG emission reductions, and**
3. **provides government level monitoring & evaluation to the performance of the system**

Hence, the GIS is crucial in achieving the 20 % GHG reduction target of the Union coupled to social benefits and resulting improvement in the national level competitiveness.

The following graph describes the costs of such an intervention, detailing each of the support schemes that were/are available in Hungary.

Figure 51: Costs and benefits of the Hungarian GIS



Source: GIS, Own calculations

It is to be noted that the analytical review indicates different levels of emission reduction costs and potential emission reduction levels per annum. From a financial perspective the "Our home" and the "Light bulbs" tenders were the winners, with prescribing the lowest cost per ton of emission reduction. Nevertheless, the biggest magnitudes of emission reductions per annum are generated by the two phases of the "Block houses" intervention.

The interventions can be grouped into 3 main sections:

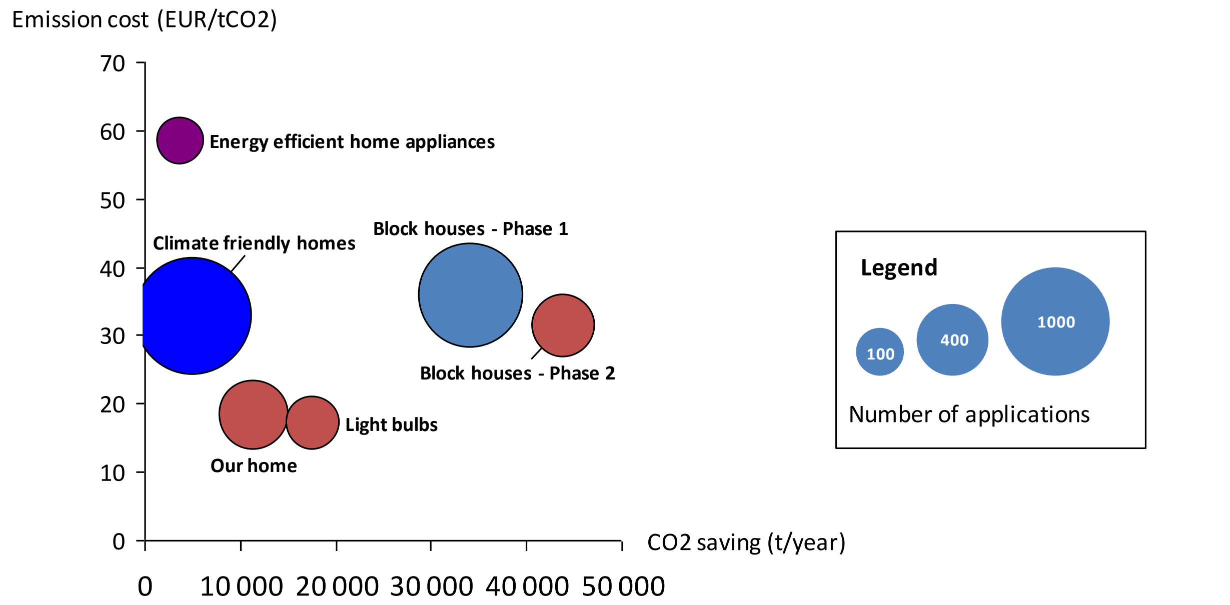
1 EUR 15-20/tCO2 reduction: Our home and Light bulbs

2 EUR 30-40/tCO2 reduction: Block houses and Climate friendly homes

3 EUR ~55/tCO2 reduction: Energy efficient home appliances

The pure reduction effect does not describe all the details of a GIS type of intervention. The following graph describes the number of applications that allowed the emission reductions achieved through the Hungarian GIS.

Figure 52: Number of applications in the Hungarian GIS



Source: GIS, Own calculations

It is easily seen that the number of applications and the cost of emission reduction are not in direct proportion to the realized emission savings. Both cheaper emission reduction options and more expensive emission reduction options have less total savings generated through the Hungarian GIS than it is the case for mid cost level interventions.

It is also to be noted that not the biggest amount of applications bring the biggest emission reductions to the economy. The bloc houses applications (phase 1 and 2) show that with fine tuning of the requirements of an application less intervention may trigger bigger positive results. Regarding to the level of intervention it is of paramount importance that the total budget of EUR ~120 million has been disbursed on national level interventions. These interventions go through a rigid approval process which leaves almost no space for any fraudulent or unfair practices in the system.

Based on this the GIS could provide a solution to the biggest problem of the project based mechanisms, namely unfair practices in emission trade that do not generate actual emission reductions but financial profits. The GIS is having the advantage of economies of scale of implementation in contrast to project based mechanisms and has a mutual benefit of cooperation with national energy efficiency, renewable energy and sustainable development targets of the country. On these bases the national level of intervention can have the combined benefit of deteriorating unfair practices of the emission market erasing the chances for MTF, arbitrage, etc. and balancing out the effect of regional fuel price differences to increase the effectiveness of global carbon emission reduction efforts.

As a final note it is to be highlighted that the GIS overall helped the realization of such emission reduction activities in the residential sector that could not have been realized without this support scheme. As the residential sector is not in the scope of emission trading, the market platforms are unable to assist their emission reduction activities and ultimately the Hungarian GIS made them viable on the short run.

Short conclusion:

GIS minimizes the risk of fraudulent activities or unfair practices in the global emission reduction activities through the transparency established in national level interventions

Based on the above, the GIS could provide a tool in extending the scope of emission trading activities. It could be used as an addition to emission trade that would provide a balancing tool in addressing the defects resulting from regional fuel price differences.

7 Conclusions & Recommendations

The study described the history of climate science, the achievements of main scholars in atmospheric analyses and the main notions in economy science established by the pioneers of environmental economics. It was not the target of the dissertation to prove climate change or global warming phenomena and instead of that listed the most important scientific evidence available in the field of climate change and backed up these with the philosophies of the precautionary principle and sustainable development. Based on the cornerstones of the two philosophies the research articulated that there is an immediate need to mitigate anthropogenic greenhouse gas emissions as there are potentially devastating outcomes on the Earth's climate if not doing so. Mature alternative technologies are already available to reform most of the spheres of economy and society which could ultimately help in drastically cutting GHG emissions and as a result mitigate risks in relation to the potential climate catastrophes.

Based on the study of environmental economics and externalities of human activities it is evident that a pool of costs has been neglected in today's economy system, including GHG emissions. There have been two main approaches identified addressing this problem, namely internalizing the external costs through taxing or through market based elements, such as the cap and trade system of emission trade. Both interventions have their pros and cons, however the cap and trade system has been analyzed in detail as this is the biggest multinational environmental protection platform ever constructed. The cap and trade system can be called as the biggest cooperation platform for environmental cooperation but surely cannot be entitled as ultimately the best system. Several attacks with more or less true arguments have questioned the relevance of emission trade and thus it became the most important target of the research to create a typology to the experienced defects of emission trade and establish the grounds for future improvement. This is an issue of great urgency as there has not been a real successor of the Kyoto Protocol accepted by the international community which has been quasi prolonged instead of substituted by a reformed system. The problems and defects have been followed by a great mistrust in the market and an opinion has strengthened that emission trade should be suspended as a whole.

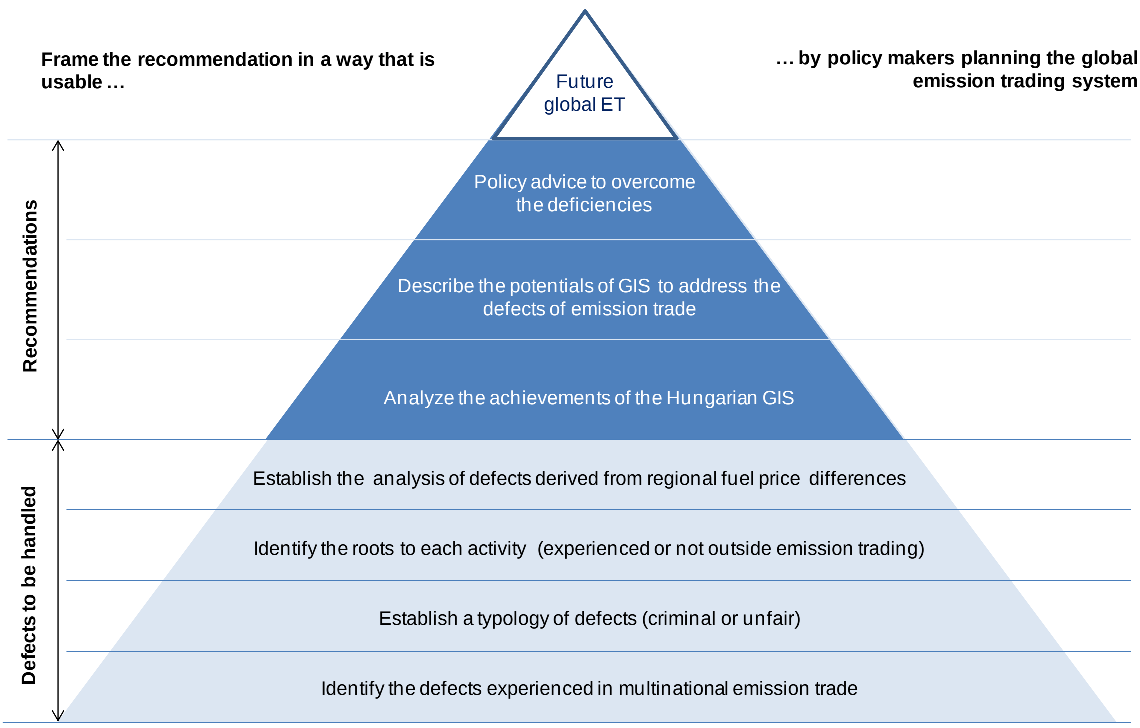
Based on the findings of the analysis emission trade is a sound tool addressing GHG emissions of industries but there is space for improvement in increasing its efficiency, transparency and in deteriorating the space for fraudulent and unfair practices. The research grabs these together under the definition:

Definition: Defects in multinational emission trade context

Regulatory regimes and/or commercial practices in emission trade which

- **are contra productive in terms of GHG emission reduction, and/or**
- **allow the generation of financial profits without producing any GHG emission mitigation benefits to the environment**

There have been a series of cases of pervasive use of emission trade systems identified, both on private and public spheres. Governments tend to make use of the loopholes in the system similarly to creative businessmen and women. Because of the complexity of the issues a logical pyramid of the research has been created:



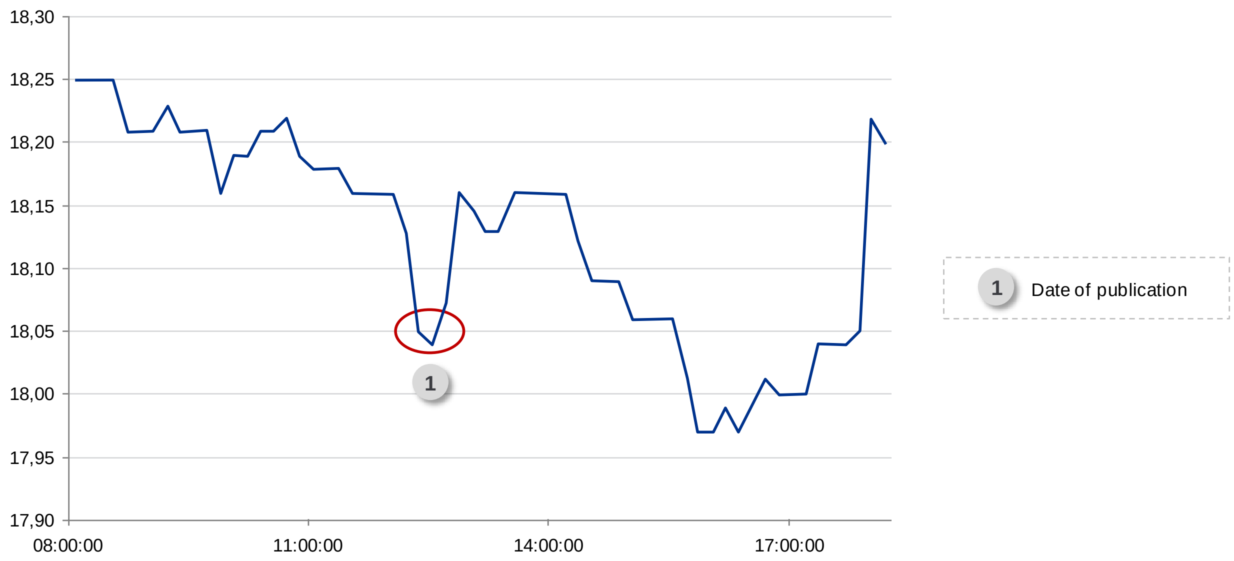
The pyramid has been vertically halved to mirror back the approach of the dissertation by devoting the bottom half to the investigation and the upper half to the recommendations peaking in a reformed global emission trade system at the top of the pyramid.

7.1 Logic pyramid: Defects to be handled

The analysis established the definition of inherent defects, i.e. lack of a decision making body and over allocation of free quotas, in multinational emission trade. Inherent defects of the system are those which can be overcome with simpler decisions of the international community. For example, the creation of a G-8 or G-20 type of meeting for decision making could have long lasting effects on the decision making capacities.

There have been other issues identified in unfair practices which are hidden in the system or are more complex that could have been identified on the basis of an administrative type of monitoring in emission trading activities. On the side of over allocation, the historical price fluctuations highlight how important the published market data are to stakeholders:

Figure 53: EUA price reaction to published 2010 data in 2011



Source: Vertis

Figure 54: EUA price reaction to published 2011 data in 2012

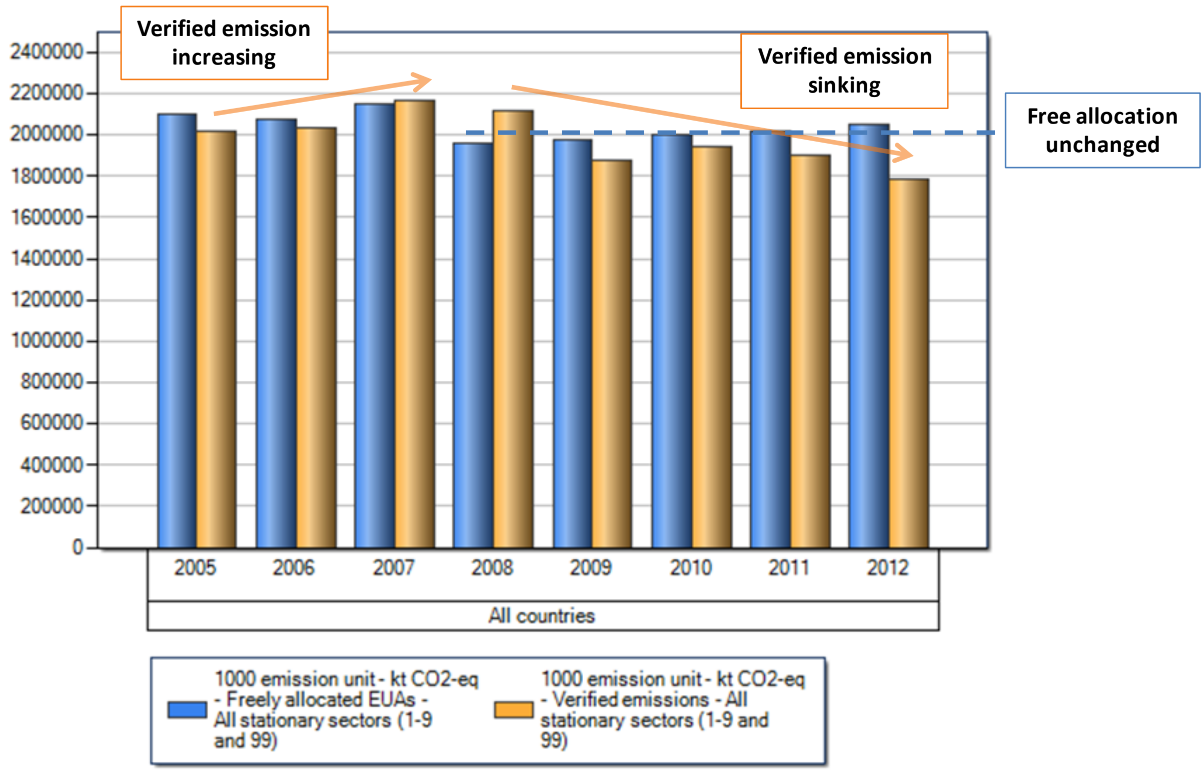
Source: Vertis

In both years the market reacted severely to the published market supply-demand information, hence the issues around over allocation are proven to have serious effects on the price levels of emission units. Unfortunately, the ETS has been unable to handle the issues of over allocation effectively till the end of the 2nd phase of the ETS. Nevertheless, the reformed approach of the 3rd phase of the ETS established the basis for addressing over allocation and its results are to be seen after the verified emissions of 2013.

It is to be seen that in the 2nd phase of the ETS the financial crisis affected the verified emission of the ETS sectors, meanwhile the level of free allocation has been unchanged. This resulted in a standard decreasing price level of emission allowances which concluded in the decreasing competitiveness of alternative technologies compared to fossil fueled traditional industries.

The reasons for the decreasing price tendency is visualized on the following graph listing the levels of free allocation and verified emissions in the framework of the EU ETS:

Figure 55: Tendencies of freely allocated quotas and verified CO2 emission in the ETS



Source: EEA, Own assessment

It is of paramount importance that the regulator needs accelerated ability to address the effects of the real economy output on emission levels and adjust allocation and caps in accordance to the changing market environment.

Apart from the inherent defects, the analysis identified two other spheres of defects, namely fraudulent and unfair practices in multinational emission trade which have been collected under the term of operational defects of emission trade. Some of these defects are related only to emission trade and can be seen as they are the result of immature market regulation and policy. There are those types of defects which are rooted to other spheres of the economy but have been made use of in emission trading. Both types shall have serious effects on the success of international climate cooperation and thus need to be addressed by policy makers on the short run.

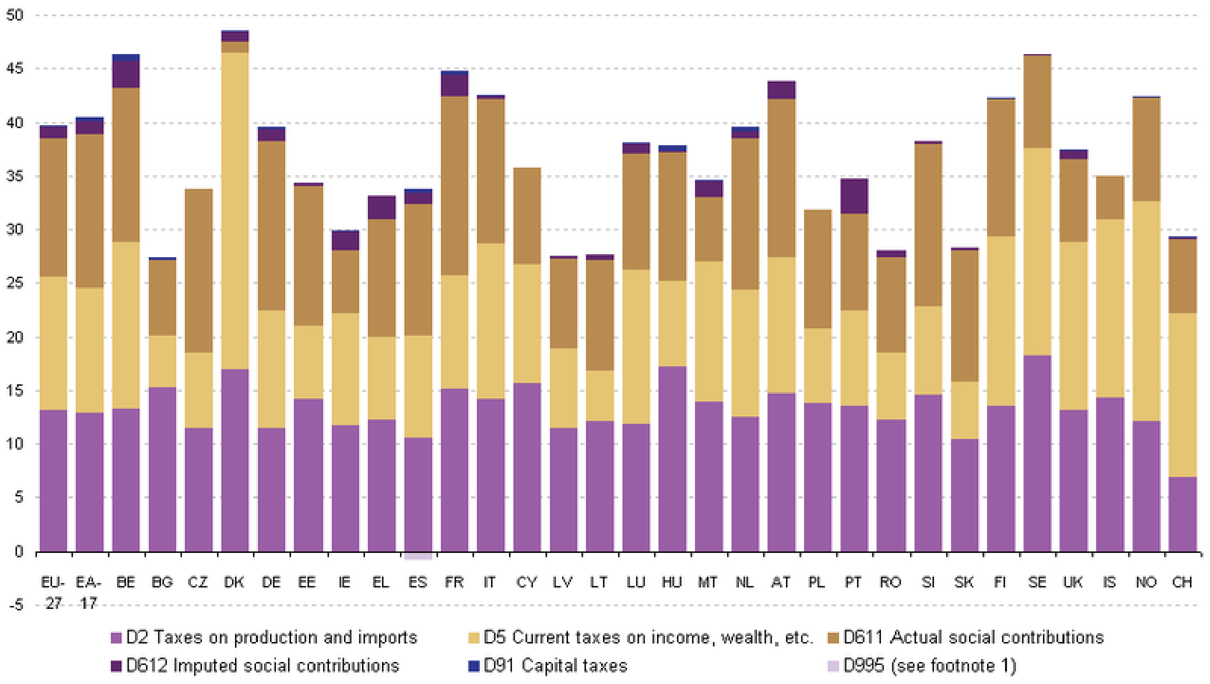
Missing trader or carousel fraud

This type of VAT fraud accounted for the biggest item, in terms of financial value, in the section of unfair practices in multinational emission trade. This type of fraud is not solely related to emission trade.

In the case of MTF the fraudster targets to collect VAT after the goods sold but instead of transferring that to the government budget it disappears quasi stealing it from the budget of the country. Although there have been serious attempts to prevent MTF there remain discrepancies between the tax system of EU member states and thus fraudsters are able to make use of these differences. Further to the differences in VAT regimes, the EU lacks a central tax authority which slows down the exchange of information between tax authorities of different countries and resultantly the fraudsters may win time to go missing.

There have been voices claiming the allowances need to be VAT free goods and there are countries, e.g. the UK which have introduced 0 % VAT but as claimed it was a decision till new measures are not implemented in the system. It is clear, based on the following graph that VAT is one of the most important government incomes (D2: Taxes on production and imports) from which the emission market shall have its share also.

Figure 56: Breakdown of tax revenue by country and main tax categories (% of GDP)



Source: Eurostat

As seen on the above graph, taxes on production and imports account for around 1/3 of the total tax revenues and out of that 50 % is rooted to VAT (**Wahrig, 2011**). Hence, one of the most important taxes is the VAT.

Based on the above the best potential approach in addressing MTF could be the sync of tax authorities in EU-27 and ultimately the creation of a European central tax authority with which the monitoring of transactions, the transfer of goods and the exchange of information could be largely eased to tackle MTF activities.

Phishing & hacking

In the case of cyberthefts the fraudsters made use of weaknesses in the IT system of covered entities or the national registries themselves. There has been great progress achieved in the field of increasing the security of the new central registry that makes it almost impossible to execute cyberthefts in the future.

After the renewal of the system in 2012, another problem arose that the registry system became excessively complicated making spot trade activities nearly impossible with new business partners. It shall be a regulatory target, to make the necessary further changes in the system to effectively support spot trading activities on the organized market platforms and exchanges.

Allowance recycling

Allowance recycling entails the potential to companies and/or governments to make use of the already surrendered emission units in a second, third, etc. transaction. This eventually results in double, triple, etc. counting of the same unit of emission quota. The option for recycling has been opened because of the linkage of the Kyoto and the ETS. Based on the linkage the ETS surrendered allowances could have been used again under the Kyoto system. The EU has implemented the necessary measures to protect the ETS from used allowances but in the case of the Protocol the measures need further implementation.

Overvaluation and additionality problems

There have been serious issues around the project based mechanisms of the Kyoto Protocol. The linkage of the ETS and the Kyoto system made the project based mechanisms a paramount option to ETS participants in covering their emissions. Unfortunately, most of the issued CER are questionable and as claimed by a series of stakeholders do not generate actual emission reduction and can be even concluded contra productive in terms of GHG mitigation.
The EU has first banned the most questioned industrial gas projects from the ETS and from 2013 all of the CERs that were not generated in the least developed countries. It brought a type of solution to the problem because this approach excludes the mostly questioned industrial gas projects of the CDM. Unfortunately, without a new international agreement the case cannot be entirely closed for the project based flexible mechanisms of the Kyoto Protocol. It is an urgent need to rethink the logic of project based mechanisms and give a chance to the national level of implementation i.e. the GIS. As discussed in detail in the evaluation of the effectiveness of the Hungarian IET and GIS there are a series of advantages which could help achieving the global emission reduction targets more effectively than in the case of project based mechanisms.

Arbitrage & quasi-arbitrage

The creation of pure financial profits was only viable through two parallel issues of the emission trading systems. The first has been discussed under the inherent defects, i.e. over allocation and the second is rooted to the linkage of the Kyoto and ETS systems. Because of the over allocation the industries experienced a governmental quasi subsidy as they received more quotas freely than they needed but further to this they could sell those quotas which they needed and change them to a cheaper Kyoto based quota. Resultantly, there have been two triggers encoded in the system which, either intentionally or unintentionally, resulted in the option for financial profit generation without any actions targeting GHG reductions or environmental protection on the side of covered industries. The EU has narrowed the credit limits of Kyoto project based mechanisms for the 3rd phase of the EU ETS and thus decreased the potential for using Kyoto credits in the EU and has also reformed the way of free allocation.

Only those entities are qualified for 100 % free allocation where carbon leakage could result in the export of GHG emissions to 3rd countries. Because of these changes the arbitrage option although with a reduced magnitude but remains open.

There is an urgent need to address all of these issues in a more effective way to avoid the pervasive utilization of the loopholes in the system accounting to about EUR 15 billion:

7.2 Logic pyramid: Quantification of the financial impact of defects in multinational emission trade

It is to be noted that based on the rule of thumb at least the same size of hidden unfair practice may have prevailed in the system as it is the magnitude of the revealed activities below.

Activity / Loss (EUR million)	Criminal	Unfair
Carousel fraud	6 763	
Phishing, hacking	40	
Allowance recycling		20
Overvaluation/additionality		4 000
Arbitrage		4 264
Total	**6 803**	**8 284**

The revealed financial amount of unfair or fraudulent activities account to about EUR 15 billion which is about 10 % of the total traded value of the emission market in 2011.

Regional fuel price differences

One of the most important scientific additions of the dissertation is the invention of the effects of the standard emission cost burden on the power generation industry. A standard CO2 burden in the EU ETS results in diverging price signals to power plant operators, hence this concludes in a methodology type operational defect of multinational emission trading.
A traditional industry is pursuing a cost minimization strategy to maintain or increase its financial profits. Although these industries see similarly to the power sector a standard

cost burden on emissions, they are able to relocate within the boundaries of the European Union if they think/know that other cost items are more preferential in another country. Industries are able to move their production to another EU member state without any hurdles if they see more attractive operating expenditures there. They are able to do this move as they will be able to export-import their produced goods through several logistic routs, e.g. motorways, rail cargo, etc. Power generation sector is different from these industrial sectors. The power transmission, although power can be exported-imported too, has its limitations on distances and thus the power sector needs to be on site in each of the countries of the EU. The presence of a strong power generation sector is also paramount to national level energy security. It means that in the case of any classic traditional production industry the ETS could be seen as a cost driver which can call the attention of the company management to review each of the cost items and drive them to rationalization or even to move to another country. With this philosophy the emission trading can even be seen as a driver for increasing competitiveness vis-à-vis the argument of skeptics of emission trading echoing the negative effects on the competitiveness of European industries.

As mentioned earlier, the case is different for the power generation sector. In the case of power generation the fuel costs are one of the most important cost elements and thus it has been selected in the modeling approach to quantify the real effects of the standard CO2 cost burden for a geographically locked industry, i.e. the power generation sector. It means because of the geographical limitations of power transmission and distribution and energy security reasons the power sector is unable to make ultimate use of the philosophy of the ETS, namely that it is the most effective market based tool that pushes the covered entities to minimize GHG emissions in a cost effective manner.

It is proven through the analyses of several countries in the dissertation that a standard CO2 cost has different effects on the power sectors of different countries having various levels of fuel costs. The power generation sector has been analyzed in detail with respect to their operating expenditures and the following formula has been developed and modeled for in depth analyses:

$$\mathbf{TMC_p\ (EUR/MWh) = MC_p + (ME_{pp} \times P_{CO2})}$$

TMCp : Total marginal cost of generating power incl. fuel, CO2, and power generation efficiency

MC_p: Marginal cost of generating unit of power (EUR/MWh)

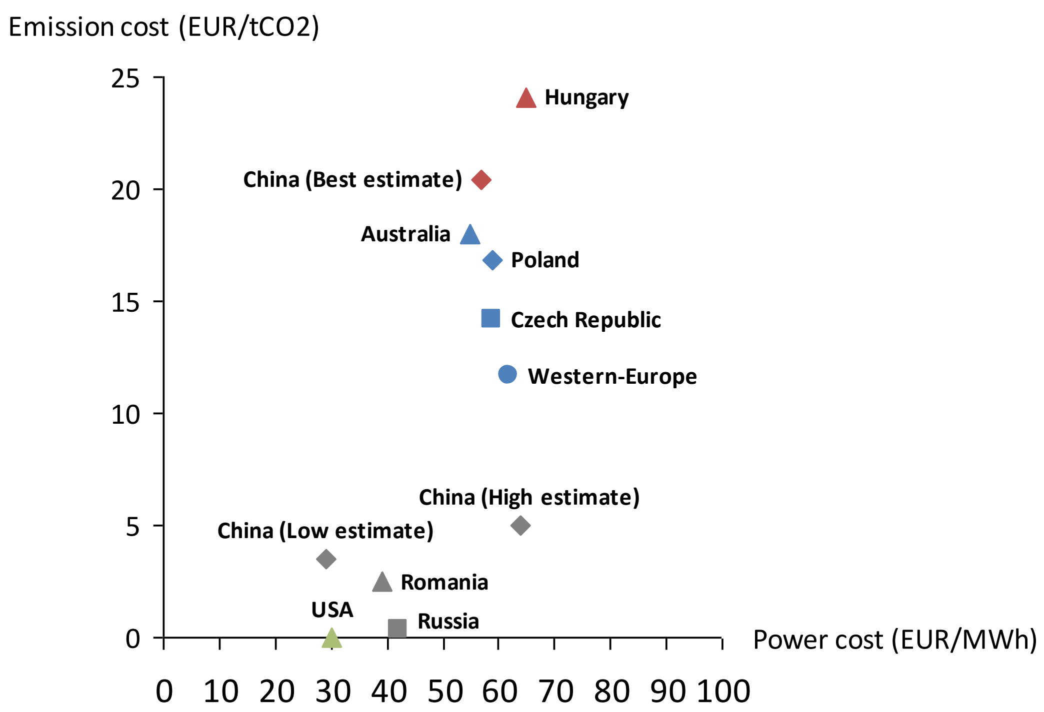
ME_{pp}: Power plant marginal emission on generating a unit of power

P_{CO2}: Price of CO2 quota

Note: The equation can be used to model the competitiveness of renewable power generation also with having EUR 0/tCO2 costs prescribed on them because of zero GHG emissions

Based on the formula above, several countries have been studied to assess the required level of CO2 costs to persuade coal fuelled power plants switching to the cleaner natural gas.

Figure 57: Breakeven of natural gas against coal based power generation on different emission cost levels



Source: Own assessment

Based on the modeling results, it can be concluded that each of the analyzed countries have a different level of breakeven for the cleaner natural gas. It means the standard CO2 cost burden on the power generation sector has diverging outcomes on the cost structures of respective power producers. The two ends of the studied countries are Hungary having the highest required cost level of emission allowances and the USA where natural gas is more competitive without any extra costs (or EUR 0/tCO2) prescribed on CO2 emissions.

Based on the results of the model and the geographical limitations of the power sector, a regulatory intervention is necessary to smooth out the differences in the cost level of different emitters.

Further to these differences, there is an urgent need to ensure that the externalities of production are fully covered in the costs of power producers. Presently, the weak emission market is unable to ensure coverage of the externalities and thus a post hoc balancing tool would be required to collect an extra fee from GHG emitters if emission market prices are inadequate to cover the externalities.

7.3 Logic pyramid: Recommendations

The target of the analysis was to draw up options which do not tumble the emission trading system but provide recommendations to improvement.

A balancing tool that has been framed in the dissertation is capable of providing a transition period to coal fueled power generators to phase out their facilities in a planned manner. The balancing tool is establishing the basis for covering externalities of production also in the case of a weak emission trade market, meanwhile increasing the competitiveness of the cleaner natural gas. One could ask why not renewable sources and fossil sources have been assessed representing the two ends of clean and dirty power generation, the answer is straightforward that it is the most urgent need of the global power generation industry to address the externalities of coal firing.

Coal fueled power generation is spreading worldwide (as discussed under the model results) except in the case of the USA which needs global action to be addressed.

The balancing tool has three main benefits:

- it smoothes out the differences between countries in the breakeven of the cleaner gas compared to the dirtier coal;
- with smoothing out the differences between countries a multinational emission trading system can have standard effects on the power generation sector of various regions
- it brings the cleaner natural gas fuelled power generators to a level playing field compared to their coal fueled competitors.

The balancing tool can be implemented through a central authority which reviews every year the fuel cost levels of different countries and different operators and based on the findings would introduce extra fees to coal fueled power generators to bring the cleaner natural gas to a level playing field and ensure that the externalities of coal fueled generation are covered.

There have been prerequisites identified for the new system:

- strong regulatory intervention needed;
- establishment of a new or reinforcement of a present institution into an International Energy Authority;
- strong energy commodity market knowledge required on the level of the regulator.

There have been operational recommendations framed to the new system:

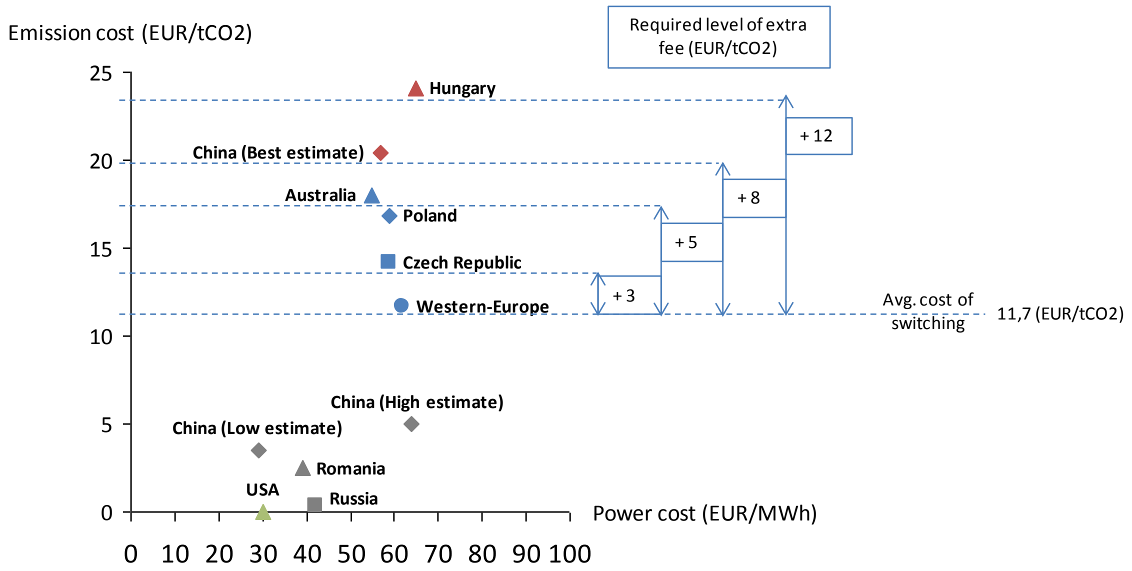
1. annual cost review executed on EU level;
2. collection of extra fee from coal power plants to finance the GIS;
3. renewable energy and energy efficiency investments to be financed through the GIS .

The two options of post hoc balancing by the Authority are:

1. balancing to an average cost of switching;
2. balancing to the actual cost of CO2 quotas.

These options are shown on the following figures:

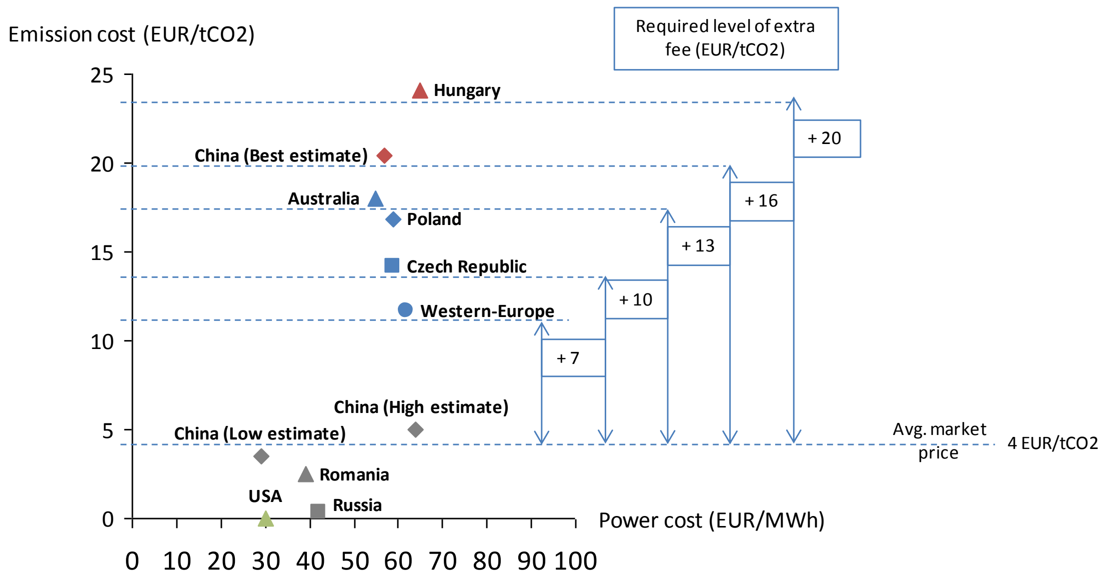
Figure 58: Post hoc balancing of CO2 costs in the power sector to the average



Source: Own assessment

This intervention could secure that there would be minor differences between the different countries of the Union (or in the case of any multinational system) in the competitiveness of gas to coal achieving level playing field to each power generator.

Figure 59: Post hoc balancing of CO2 costs in the power sector to CO2 market price



Note: avg. market price as of H1 2013

Source: Own assessment

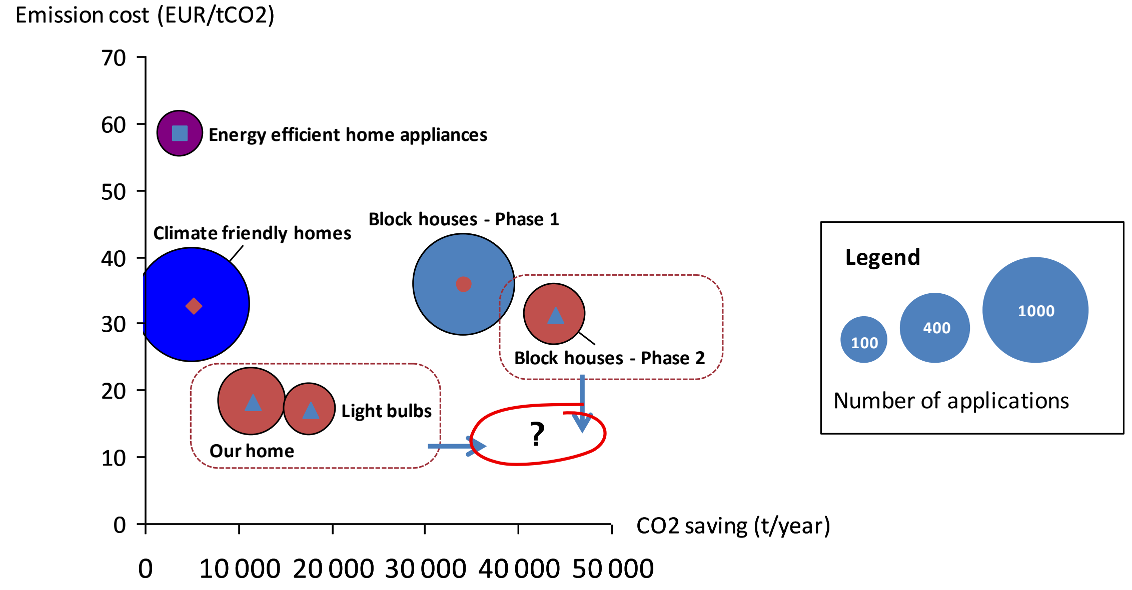
In both cases the coal fuelled power generators would see an extra tariff on every MWh power generated only in that case when the emission market is weak. In case of the second option the natural gas fueled power generation may become competitive to coal in any circumstances and in each participating country. It was paramount importance to put such recommendations on the table which allow a natural transformation of the power generation sector. Hence, in cases of both post hoc balancing options coal fueled power generators would be able to maintain their activities on a level playing field with the cleaner techniques that could allow a natural restructuring of the power sector.

Green Investment Scheme to assist bleaching multinational emission trade

The GIS may provide a solution to identify measures to unfair practices or fraudulent activities and thus can provide a new strategy to future multinational emission trade systems. These have a major impact on the success of any emission trade regime and thus an approach that is able to provide solutions could help the success of the coming rounds of climate negotiations. The national level of intervention on the one hand can bring advantages in terms of economies of scale and on the other hand the governmental level implementation considerably could reduce the space for fraudulent or unfair practices in emission trade.

It is foreseen that the GIS is able to address both the deficiencies of fuel price differences and fraudulent activities to enhance the operation of emission trade. The GIS type of interventions could be used for such emission reduction activities also which are not covered by the emission trade and resultantly extend the benefits of global emission trading regimes. The following graph indicates which type of interventions have been the most successful in the case of Hungary and identifies the direction of further improvements in the operation of the GIS.

Figure 60: Interventions with the lowest administrative burden, lowest costs of emission reduction and with the biggest annual GHG mitigation



Source: Own assessment

Based on the analysis of the performance of the Hungarian GIS the best performing three interventions are the following:

GIS Block houses phase 2:

Scope of the interventions covered door and window changes; insulation; building engineering improvements such as heating, elevators, ventilation; renewable energy utilization; shading; passive solar heating.

GIS Light bulbs:

Scope of the interventions focused to underprivileged social groups and covered change of old light bulbs to new efficient ones. Further to this the program covered the collection and the disposal of the hazardous wastes of old bulbs.

GIS Our home:

Scope of the interventions focused to energy efficiency interventions and renewable energy investments in family houses.

In all of the three cases the cost of emission reduction falls in the range of EUR 10-30 /tCO2. The best performing two interventions in terms of cost of emission reduction are the “Our home” and the “Light bulbs” having their costs of reduction between EUR 10-20 /tCO2. Nevertheless the low costs of avoiding emissions, their magnitude in terms of

total saving is smaller between 10 thousand and 20 thousand tons of CO_2 per annum. In this respect the “Block houses - Phase 2” intervention performed the best achieving more than 40 thousand ton of CO_2 reduction per annum. The ultimate target of another round of the GIS shall be to increase the magnitude of savings for the “Our home” and the “Light bulbs” programs and decrease the CO_2 reduction costs for the “Block houses- Phase 2” project.
As of this research the GIS made great success in both CO_2 reduction, and social development, nevertheless the communication of the program and its achievements are somewhat weak. Communication would be in any case one of the prerequisites for sustainability of the system as without marketing it cannot be promoted throughout the world. Meaning, that apart from the quantifiable corrections on the side of cost of emission reductions and magnitude of annual savings in the case of GIS programs it should be a major target to enhance communication of the interventions and the preparation for a worldwide marketing campaign.

Summing up the conclusions of the dissertation it can be highlighted that the climate cooperation has achieved unprecedented success in the field of multinational environmental cooperation and its market based instrument, namely emission trade, made an indisputable achievement in paving the way for business wise tools in environmental protection. Both global cooperation and market based mechanisms are new and bear the difficulties of immature regulation and policy. These resulted in contra productive tendencies in the system thus there is an urgent need to reform it. On the way of renewing the international climate cooperation it is the most paramount goal to ensure that emitters cover the externalities of production hence, a strong intervention into the emission market is inevitable. The reform of the system with a renewed role of GIS interventions shall bring long lasting benefits to sustainable development and climate protection agendas. Reform to the system is paramount with respect to the questionable outcomes of the climate negotiations in Doha, Durban and Cancun. The Doha meeting although initiated the second commitment period of the Kyoto Protocol with the acceptance of the Doha Amendment, nevertheless the parties are not the same as they were in the first period questioning on the one hand the seriousness of such important international cooperation platforms and on the other hand the long-term sustainability of the entire system.

7.4 Synthesis of the dissertation

Three main hypotheses have been analyzed thoroughly in the research:

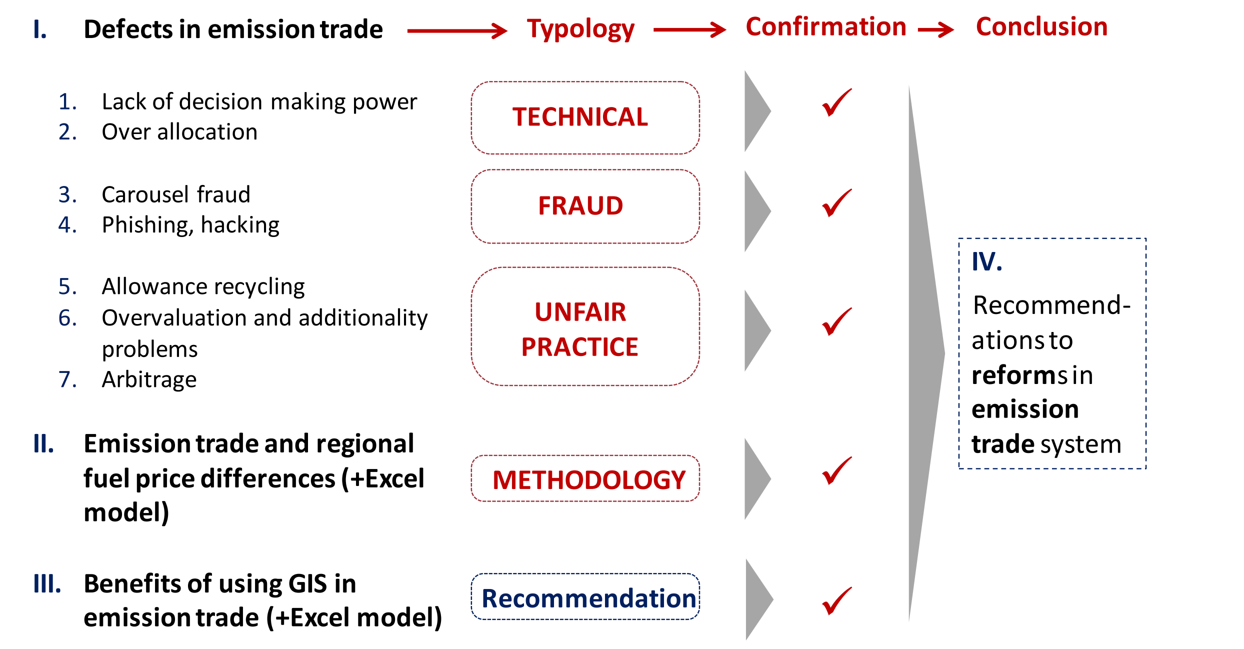
I. There are defects in emission trading systems which hinder the cooperation addressing climate change and the actions mitigating anthropogenic GHG emissions.

II. A common multinational emission trading system has diverging or contra productive effects on entities which are unable to relocate, e.g. in the case of the power generation sector which experiences regional fuel price differences.

III. A GIS type of intervention and a balancing mechanisms introduced to the power sector is capable of reducing the space for unfair practices, ensure that externalities of production are covered, increase the competitiveness of cleaner power generation, and help the widespread of alternative energy sources.

For each hypothesis the research provided confirmation also by the help of typology development as seen on the following figure:

Figure 61: Recommendations based on the confirmation of the hypotheses



Source: Own assessment

Based on the confirmation of the hypotheses conclusions & recommendation have been identified to a reformed future emission trading system which address each of the defects confirmed through the study.

IV. Recommendations identified through typology development and confirmation of each of the hypotheses

There are defects in multinational emission trading systems which fall under different typologies (technical, fraud, unfair practice):

- Technical defects have significant impact on the operation of multinational emission trading although these may be handled with rather simple decisions of the international community.
- Fraudulent activities are well known through similar trading abuses outside of emission trade which require deep regulatory intervention for synchronization of tax systems and police activities.
- Unfair practices although cannot be claimed criminal have severe negative effects on the operation of emission trade which may be overcome through deep regulatory reforms.

A multinational emission trading system has diverging effects on sectors unable to relocate their activities, e.g. in the case of the power generation sector facing considerable differences in regional fuel prices:

- Fuel price differences and their effect on GHG emission mitigation in the power sector can be addressed through a regulatory intervention of post hoc balancing.
- Post hoc balancing have two fold advantages: 1. smoothes out the differences between countries in the breakeven of the cleaner natural gas compared to the dirtier coal; 2. ensures that externalities of coal fueled power generation are covered.
- Further to these, it provides a solution where coal fueled generators are able to continue their operation in a competitive manner.

The Green Investment Scheme provides a proven experience which is capable of addressing the defects and at the same time propagating the benefits of emission trading:

- National or sector level intervention with auditable GHG mitigation results reducing the space to unfair and fraudulent activities.
- Can be utilized as a tool for balancing mechanisms ensuring that externalities of production are covered in the power sector.
- Extends the boundaries of emission trading to sectors which are not covered yet.
- Establishes social benefits coupled to emission reductions.

The present analysis provided a review of emission trading, its qualitative and quantitative parameters, its defects in general, and addressed the potential ways for improvement. Hence, the study filled in the gap of scientific and economy analyses in the field of emission trading.

8 OPPORTUNITIES FOR FUTURE RESEARCH

As discussed in the modeling methodology developed for the analysis of regional fuel price differences, the model established a simplified approach to analyze the breakeven of the cleaner natural gas compared to the dirtier coal based power generation. For this purpose national level fuel costs have been utilized. For the purpose of future regulatory interventions in balancing out the differences between countries a more detailed approach can be implemented for which detailed power plant cost data are necessary. It is a paramount target to execute the more detailed analysis before any interventions are implemented in the multinational climate cooperation.

As stated in the modeling methodology, the model is capable of deriving useful results in the case of renewable power generation. The model focused on the competitiveness of natural gas compared to coal as a factor of CO2 prices. Meanwhile, the analysis may be extended to quantify the breakeven of different renewable energy sources compared to fossil fueled power generation. Based on this another field of future research in parallel to the power plant level cost assessments is the detailed analysis of renewable power generation alternatives to natural gas or coal.

The third sphere of future studies is focusing on the performance of the GIS interventions. The GIS has been indicated as having potentials both on the side of reducing unfair and fraudulent practices in emission trade and on the side of balancing out the differences in the breakeven of the cleaner natural gas in the power generation sector of respective countries of the European Union. Because of both potentials it is of paramount importance to further analyze the potential linkages of the Kyoto protocol and the local, national, and regional emission trading regimes identifying further potential spheres of cooperation which could help realizing the potential of long-lasting benefits of the IET backed up with GIS.

Last but not least, further cost benefit analyses are needed on the side of GIS programs to enhance the activities of interventions. As the GIS may provide a new tool in multinational emission trading regimes it is of great importance to establish the best approaches in terms of costs of emission reductions and magnitude of emission savings realized.

9 Reference list

Agassiz M. L. 1837. *Upon Glaciers, Moraines, and Erratic Blocks*; being the Address delivered at the opening of the Helvetic Natural History Society, at Neuchatel, on the 24th of July 1837, by its President, M. L. Agassiz. The Edinburgh New Philosophical Journal

Air Resource Board, 2012. *Cap and trade*. **http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm** [Consulted on 11.10.2012.]

Arrhenius, S. 1896. *On the Influence of Carbonic Acid in the Air Upon the Temperature of the Ground*. Philosophical Magazine

Arrhenius, S. 1908. *Worlds in the making. The evolution of the universe*. Harper & Brothers Publishers, New York and London

Australian Government (AuGov), 2012. *Energy in Australia 2012*. Commonwealth of Australia, Canberra

Baker & McKenzie, 2012. *CDM Rulebook*. **http://cdmrulebook.org/** [Consulted on 02.02.2013]

Bentham, J., 1776. *A Fragment on Government.* Printed for T. PAYNE, at the Mews-Gate; P. EMILY, opposite Southampton-Street in the Strand; and E. Brooks, in Boll-Yard, Temple-Bar

Bell ML, et al. 2004. *A Retrospective Assessment of Mortality from the London Smog Episode of 1952: The Role of Influenza and Pollution*. Environmental Health Perspectives, NY

Bloomberg, 2013. *McCloskey Group Ltd Physical Prices & Indices: Steam Coal Spot FOB prices* (23.01.2013). Bloomberg.

Bloomberg, 2013. *Low Sulfur Compliance Coal Spot Price/Big Sandy Barge Fob* (25.01.2013). Bloomberg.

Bruntland, G. (ed.), 1987. *Our common future: The World Commission on Environment and Development*. Oxford, Oxford University Press

Burgess, E., 1837. *General Remarks on the Temperature of the Terrestrial Globe and the Planetary Spaces; by Baron Fourier*. American Journal of Science, Translation from the French, of Fourier, J. B. J., 1824, "Remarques Générales Sur Les Températures Du Globe Terrestre Et Des Espaces Planétaires.", Annales de Chimie et de Physique.

Business Insider, 2010. "Can The Chinese Coal Monster Carry Global Demand?" **http://www.businessinsider.com/can-the-chinese-coal-monster-carry-global-demand-2010-7** [Consulted on 10.08.2011.]

Carbonretirement, 2011. *Large hydro project in India under scrutiny – Wikileaks puts integrity of UN carbon offsetting scheme under question*. **http://www.carbonretirement.com/content/large-hydro-project-india-under-scrutiny-%E2%80%93-wikileaks-puts-integrity-un-carbon-offsetting-sch** [Consulted on 10.12. 2012.]

Central and Eastern European Gas Exchange (CEEGEX), 2013. *Day ahead market*. **https://www.ceegex.hu/hu/Lapok/default.aspx** [Consulted on 02.01.2013]

Center for Climate and Energy Solutions (C2ES), 2012. *GHG Emission for Major Economies. **http://www.c2es.org/facts-figures/international-emissions/annual-ghg*** [Consulted on 02.11.2012]

Central European University (CEU), 2013. *Code of Ethics of the CEU; Ethical Research Policy; Ethical Research Guidelines*. CEU, Budapest.

Coase, R. H. 1960. *The Problem of Social Cost*. Journal of Law and Economics, The University of Chicago Press

COP18, 2012. *United Nations Climate Change Conference*. **http://www.cop18.qa/en-us/aboutcop18cmp8/participants.aspx** [Consulted on 05.01.2013.]

Corporatewatch, 2010. *The Carbon Carousel: VAT Tax Fraud*. **http://www.corporatewatch.org/?lid=3676** [Consulted on 22.12.2011.]

Dailyrecord, 2011. *Crack squad sent to Dubai to stop VAT fraudsters from bankrupting Britain*. **http://www.dailyrecord.co.uk/news/scottish-news/crack-squad-sent-to-dubai-to-stop-1086715** [Consulted on 22.12.2011.]

Daniels Trading, 2012. *Commodity Outlook*. **http://www.danielstrading.com/resources/newsletter/2012/01/24/** [Consulted on 22.12.2012.]

DomGas Alliance, 2012. *Australia's Domestic Gas Security*. **http://www.domgas.com.au/0054A02C-31C0-4C61-848C-D069C605C872/FinalDownload/DownloadId-163B8012D6657FD127F6E1850AB29392/0054A02C-31C0-4C61-848C-D069C605C872/pdf/Alliance_reports/DomGas%20Report%202012.pdf** [Consulted on 22.01.2013.]

Economist, 2012. *America's falling carbon dioxide emissions*. **http://www.economist.com/blogs/schumpeter/2012/05/americas-falling-carbon-dioxide-emissions** [Consulted on 22.12.2012.]

EEC, 1958. *Treaty establishing the European Economic Community*. European Economic Community, Rome

Europa Press, 2012. *Emissions trading: Commission clears temporary free allowances for power plants in Bulgaria, Czech Republic and Romania*. **http://europa.eu/rapid/press-release_MEMO-12-530_en.htm** [Consulted on 09.09.2012.]

Eurocanet, 2009. *Group of experts on VAT carousel fraud*. **http://expertgroups.govtrace.com/group-of-experts-on-vat-carousel-fraud-eurocanet** [Consulted on 09.10.2012.]

European Union, 1992. *The Maastricht Treaty, Provisions Amending the Treaty Establishing the European Economic Community with a View to Establishing the European Community*. Maastricht

European Commission, 2003. *Directive 2003/87/EC, entered into force on 25 October 2003*. Official Journal of the European Union, Bruxelles

European Commission, 2007. *Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council(notified under document number C(2007) 3416) (Text with EEA relevance) (2007/589/EC)*. Official Journal of the European Union, Bruxelles

European Parliament and Council, 2009. *DIRECTIVE 2003/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 October 2003; amended by Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009*. Official Journal of the European Union, Bruxelles

European Commission, 2011. "*EU ETS Registries: Transitional measure to end on 20 April with the reinstatement of the national registry of Lithuania*. **http://ec.europa.eu/clima/news/articles/news_2011041901_en.htm** [Consulted on 06.06.2011.]

European Commission, 2011. *COMMISSION REGULATION (EU) No 550/2011 of 7 June 2011on determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, certain restrictions applicable to the use of international credits from projects involving industrial gases*. Official Journal of the European Union, Bruxelles

European Commission, 2011. *COMMISSION DECISION of 27 April 2011 determining transitional Union-wide rules for harmonised free allocation of emission allowances pursuant to Article 10a of Directive 2003/87/EC of the European Parliament and of the Council*. Official Journal of the European Union, Bruxelles

European Commission, 2012. *Latest information: European Union Transaction Log.* **http://ec.europa.eu/environment/ets/** [Consulted on 11.08.2012.]

European Commission, 2012. *National Allocation Plans*. **http://ec.europa.eu/clima/policies/ets/registry/documentation_en.htm** [Consulted on 11.08.2012.]

European Commission, 2013. *The EU Emissions Trading System (EU ETS).* ***http://ec.europa.eu/clima/policies/ets/index_en.htm*** [Consulted on 15.01.2013.]

European Council, 2004. *2004/101/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms*. Official Journal of the European Union, Bruxelles

European Council, 2008. *COUNCIL DIRECTIVE 2008/8/EC of 12 February 2008 amending Directive 2006/112/EC as regards the place of supply of services*. Official Journal of the European Union, Bruxelles

European Council, 2009. *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 Community and amending Council Directive 96/61/EC*. Official Journal of the European Union, Bruxelles

European Environment Agency (EEA), 2012. *GHG emissions in the EU-27 by gas and by sector*. **http://www.eea.europa.eu/data-and-maps/figures/ghg-emissions-in-the-eu** [Consulted on: 15.12.2012.]

European Environment Agency (EEA), 2010. *Total EU GHG emissions by sector and by gas, 1990–2008*. **http://www.eea.europa.eu/data-and-maps/figures/total-eu-ghg-emissions-by** [Consulted on: 15.12.2012.]

European Environment Agency (EEA), 2005. *Prices of CO2 allowances from June 2003 until June 2005*. **http://www.eea.europa.eu/data-and-maps/figures/prices-of-co2-allowances-from-june-2003-until-june-2005** [Consulted on: 08.01.2013.]

European Environment Agency (EEA), 2013. *ETS data viewer*. **http://www.eea.europa.eu/data-and-maps/data/data-viewers/emissions-trading-viewer** [Consulted on 20.05.2013.]

European Energy Exchange (EEX), 2012. *Natural Gas Spot*. **http://www.eex.com/en/** [Consulted on 21.08.2012.]

Europol, 2009. *Carbon credit fraud causes more than 5 billion Euros damage for European taxpayers*. **https://www.europol.europa.eu/content/press/carbon-credit-fraud-causes-more-5-billion-euros-damage-european-taxpayer-1265** [Consulted on 21.10.2010.]

Europol, 2010. *Further investigations into VAT fraud linked to the carbon emission trading system*. **https://www.europol.europa.eu/content/press/further-investigations-vat-fraud-linked-carbon-emissions-trading-system-641** [Consulted on 21.10.2011.]

Eurostat, 2011. *Breakdown of tax revenue by country and by main tax categories (percentage of GDP).* ***http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:5_Breakdown_of_tax_revenue_by_country_and_by_main_tax_categories(percentage_of_GDP).PNG&filetimestamp=20120105113223*** [Consulted on 21.10.2012.]

Fourier, J. B. J., 1827. *MEMOIRE sur les temperatures du globe terrestre et des espaces planetaires* [translated: *General Remarks on the Temperature of the Terrestrial Globe and the Planetary Spaces]*, Memoires de l'Acadeémie Royale des Sciences, Vol. 7. **http://gallica.bnf.fr/ark:/12148/bpt6k32227.image.f808.tableDesMatieres.langEN** [Consulted on: 11.12.2011.]

Gerlach, T. M., 1991, *Present-Day CO2 Emissions from Volcanoes*, EOS, Transactions, American Geophysical Union, Vol. 72.

Gilbertson, T., 2011. *Fraud and scams in Europe's Emissions Trading System*. **http://climateandcapitalism.com/2011/05/05/fraud-and-scams-in-europes-emissions-trading-system/** [Consulted on 22.12.2012.]

Google, 2012. *About phishing*. **http://support.google.com/accounts/bin/answer.py?hl=en&answer=75061** [Consulted on 22.08.2012.]

Green Investment Scheme (GIS), 2012. *Annual Report 2011*. Ministry of Environment and Water, Budapest

Guissani, V, 1994. *The UK Clean Air Act 1956: An Empirical Investigation.* Centre for Social and Economic Research on the Global Environment, University College London and University of East Anglia. **http://www.uea.ac.uk/env/cserge/pub/wp/gec/gec_1994_20.pdf** [Consulted on 14.12.2011.]

Hanson, N, 2009. *Grävande journalistic* [Translated: Investigative Journalism]. **http://www.journalismfund.eu/what-investigative-journalism** [Consulted on 14.03.2013.]

IntercontinentalExchange, 2012. *Global markets in clear view*. **https://www.theice.com/about.jhtml** [Consulted on 21.08.2012.]

IntercontinentalExchange, 2012. *EUA price tendencies*. **http://m.cdn.blog.hu/me/megujulok-maskent/image/co2%20price.png** [Consulted on 21.08.2012.]

International Energy Agency (IEA), 2010. *Projected Costs of Generating Electricity*. IEA/NEA/OECD, Paris

International Energy Agency (IEA), 2012. *World Energy Outlook 2012*. OECD/IEA, Paris

IGES, 2012. *CDM/JI Project Data*. **http://www.iges.or.jp/en/cdm/report_cdm.html** [Consulted on 21.08.2012.]

Intergovernmental Panel on Climate Change (IPCC), 1990. *Climate Change. First Assessment Report (AR1) The IPCC Scientific Assessment*. Cambridge University Press, Cambridge

Intergovernmental Panel on Climate Change (IPCC), 1995. *Climate Change 1995. The Science of Climate Change: Summary for Policymakers and Technical*

Summary of the Working Group I Report. Cambridge University Press, Cambridge

Intergovernmental Panel on Climate Change (IPCC), 2001. *Climate Change 2001. The Scientific Basis.* Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

Intergovernmental Panel on Climate Change (IPCC), 2007. *Climate Change. Fourth Assessment Report (AR4).* The IPCC Scientific Assessment. Cambridge University Press, Cambridge

Jones M.D.H. et al. 1990. *History of the greenhouse effect*. Originally published in Progress in Physical Geography and reprinted 1995 in the book Global Warming: Selected Reprints by John W. Firor. American Association of Physics Teachers

Quebec Ministry of Environment, 2012. "The Carbon market". Consulted on 18.12.2012.
http://www.mddep.gouv.qc.ca/changements/carbone/index-en.htm

Kawulich, B.B 2005. *Participant Observation as a Data Collection Method*. FQS – Forum: Qualitative Social Research, Volume 6, No. 2, Art. 43.

KPMG, 2011. *Energetikai Évkönyv*. [Translated: *Energy Yearbook]*. KPMG, Budapest

KVVM, 2010. *Hazánk 4 milliárd forintnyi kiotói kvótaeladásról kötött szerződést - eddig 40 milliárd a teljes kvótabevétel*. [Translated: *Hungary contracted HUF 4 billion in CO2 sales – HUF 40 billion total incomes up to date]* **http://www.kvvm.gov.hu/index.php?pid=1&sid=1&hid=2576** [Consulted on 16.8.2011.]

Lide, D.R. et al., 1997. *CRC Handbook of Chemistry and Physics: a ready-reference book of chemical and physical data* (78th edition), CRC Press.
Los Angeles Country Board of Supervisors, (1997). *The Southland's War on Smog: Fifty Years of Progress Toward Clean Air*. **http://www.aqmd.gov/news1/Archives/History/marchcov.html** [Consulted on: 10.12.2011.]

Magyar Nemzet Online, 2013. *Brüsszel jóváhagyta a magyar kérést*. [Translated: *Bruxelles approved the Hungarian request*.] **http://mno.hu/energia/brusszel-jovahagyta-a-magyar-kerest-1125974** [Consulted on 19.12.2013.]

Ministry of Environment and Water (MoEW), 2007. 2007. évi LX. törvény az ENSZ Éghajlatváltozási Keretegyezménye és annak Kiotói Jegyzőkönyve végrehajtási keretrendszeréről. [Translated: *No. LX. Law (Implementing the United Nations Framework Convention on Climate Change and Kyoto Protocol).*] Budapest.

Ministry of Environment and Water (MoEW), 2007. *323/2007. (XII. 11.) Korm. Rendelet az ENSZ Éghajlatváltozási Keretegyezménye és annak Kiotói Jegyzőkönyve végrehajtási keretrendszeréről szóló 2007. évi LX. törvény végrehajtásának egyes szabályairól*. [Translated: *323/2007. (XII.11) Government Decree. (implementation of 2007 No. LX. Law United Nations Framework Convention on Climate Change and its Kyoto Protocol)*]. Budapest.

Ministry of Environment and Water (MoEW), 2008. *Nemzeti Éghajlaváltozási Stratégia*. [Translated: *National Climate Change Strategy*]. Budapest

Ministry of Environment and Water (MoEW), 2008. “Brief on implementation of emission reduction activities” – Confidential

National Aeronautics and Space Administration, 2012. *GISS Surface Temperature Analysis. 2011*. **http://data.giss.nasa.gov/cgi-bin/gistemp/do_nmap.py?year_last=2011&month_last=11&sat=4&sst=1&type=anoms&mean_gen=11&year1=2011&year2=2011&base1=1951&base2=1980&radius=1200&pol=reg** [Consulted on: 12.15.2012.]

National Aeronautics and Space Administration, 2001. “The Carbon Cycle” **http://earthobservatory.nasa.gov/Features/CarbonCycle/** [Consulted on: 12.15.2012.]

O'Riordan, T. ,Cameron, J. ed., 1994. *Interpreting the Precautionary Principle*. Cameron May Ltd., London

N-TV, 2012. *Razzia bei Deutscher Bank*. [Consulted on 12.12.2012 **http://www.n-tv.de/wirtschaft/Steuerbetrug-bei-Deutscher-Bank-article9758586.html**

New York Times, 2011. *E.U. Closes Emissions Trading System After Thefts*. **http://www.nytimes.com/2011/01/20/business/global/20iht-carbon20.html?_r=3&partner=rss&emc=rss&** [Consulted on 09.08.2011.]

New York Times, 2012. Subsidies for a Global Warming Gas. **http://www.nytimes.com/interactive/2012/08/09/world/subsidies-for-a-global-warming-gas.html?ref=asia** [Consulted on 08.08.2012.]

New World Resources, 2013. *NWR Trading Update and Q1 2013 Prices*. NWR, Amsterdam

Petit, J.R. et al, 1999. *Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica*. Nature, London

Petit, J.R., et al., 2001. *Vostok Ice Core Data for 420,000 Years*, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2001-076. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA. **ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/vostok/co2nat.txt** [Consulted on: 15.02.2012.]

Pigou, A. C. 1932. *The Economics of Welfare*. Macmillan and Co. London.

Royal Canadian Mounted Police (RCMP), 2013. *Criminal Investigative Analysis.* ***http://www.rcmp-grc.gc.ca/tops-opst/bs-sc/crim-profil-eng.htm*** [Consulted on 10.01.2013.]

Heimdal, C. et al. 2012. *Carbon 2012: A market waiting for Godot*. Thomson Reuters Point Carbon

Opten, 2013. *Cégtár*. [Translated: *Company database*]. Opten, Budapest

Point Carbon, 2009. *Hungary nets $134 million from AAU sales*. **http://www.pointcarbon.com/news/1.1099294** [Consulted on 17.04.2009.]

Politiken, 2010. *DK centre for CO2 fraud*. **http://politiken.dk/newsinenglish/ECE1129571/dk-centre-for-co2-fraud/** [Consulted on 15.12.2010.]

Prague Daily Monitor, 2012. Police suspect two of carbon credit fraud worth CZK 378m. **http://praguemonitor.com/2012/10/24/police-suspect-two-carbon-credit-fraud-worth-czk-378m** [Consulted on 15.11.2012.]

Riebeek, H. 2005. *Paleoclimatology: Introduction.* NASA Earth Observatory. **http://earthobservatory.nasa.gov/Features/Paleoclimatology/** [Consulted on 14.12.2011.]

Saga Commodities, 2012. *Overview Of The Spread From The Swap Euas - Kyoto Credits Under The EU ETS*. **http://sagacommodities.com/?cid=7&NewsId=159&lng=en** [Consulted on 15.11.2012.]

Smith, A. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. MetaLibri, 2007

Sourcing, 2012. *TTF indexált árformulában is nagy a verseny a földgázkereskedők között*. [Translated: *Growing competition between TTF indexed natural gas traders*] **http://www.sourcing.hu/aktualis/ttf_indexalt_arformulaban_nagy_verseny_foldgazkereskedok_kozott** [Consulted on 15.04.2012.]

Spencer R. W. 2003. *The discovery of global warming.* First Harvard University Press, Cambridge

Tyndall J., 1861, *On the Absorption and Radiation of Heat by Gases and Vapours, and on the Physical Connexion of Radiation, Absorption, Conduction.-The Bakerian Lecture*. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, Series 4, Vol. 22.

Tyndall J., 1872. *Contributions to Molecular Physics in the Domain of Radiant Heat*. **http://en.wikipedia.org/wiki/File:TyndallsSetupForMeasuringRadiantHeatAbsorptionByGases_annotated.jpg** [Consulted on 22.10.2010]

Tuerk, A. et al. 2010. *Working Paper: Green Investment Schemes: First experiences and lessons learned.* Joanneum Research - Institute of Energy Research. Graz, Austria

United Nations, 1992. *World Conference on Environment and Development.* **http://www.un.org/geninfo/bp/enviro.html** [Consulted on 11.12.2011.]

United Nations, 1998. *Kyoto Protocol To The United Nations Framework Convention On Climate Change*. Kyoto, Japan

UNEP, 1972. *Report Of The United Nations Conference On The Human Environment*. **http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97** [Consulted on: 11.12.2011.]

UNEP, 1992. *Rio Declaration on Environment and Development.* Rio de Janeiro, **http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163** [Consulted on: 11.12.2011.]

UNFCCC, 2001. *Conference of Parties #7, Marrakesh Accords*. **www.unfccc.int** [Consulted on: 10.01.2012.]

UNFCCC, 2012. *Statement of the Head of Delegation of the Republic of Kazakhstan at the High Level Segment*. **http://unfccc.int/files/meetings/durban_nov_2011/statements/application/pdf/111208_cop17_hls_kazakhstan.pdf** [Consulted on: 11.12.2011.]

Valaska, J. 2012. "Az új EU ETS bevezetésének hatása a szénalapú villamosenergia-termelésre". [Translated: *Effects of the new ETS on coal fueled power generation.*] Conference: III. Energy Summit Hungary 2012, Budapest

Vertis, 2013. "2012. évi kibocsátási adatok publikálása". [Translated: *Publication of verified emissions of 2012*.] Vertis newsletter, Budapest.

Világgazdaság, 2010. *Felbolydult a kvótapiac a magyar értékesítésű CER-ek miatt.* [Translated: *Turmoil in emission trade market after Hungarian CER sales*] **http://www.vg.hu/gazdasag/gazdasagpolitika/felbolydult-a-kvotapiac-a-magyar-ertekesitesu-cer-ek-miatt-309584** [Consulted on 11.04.2010.]

Világgazdaság, 2012. *Hamisították Fellegi aláírását*. [Translated: *Signature forgery of Minister Fellegi*]. **http://www.vg.hu/kozelet/tarsadalom/hamisitottak-fellegi-alairasat-feljelentest-tett-az-nfm-375096**. [Consulted on 14.05.2012.]

Wahrig, L. 2011. *Statistics in focus: Tax revenue in the European Union*. Eurostat, Bruxelles

Whitman C.T., 2001. *U.S. Pulls Out of Kyoto Protocol*. **http://www.mapcruzin.com/news/news032901a.htm** [Consulted on 12.02.2012.]

Wikileaks, 2011. *Carbon Credits Sufficient But Not Necessary for Sustaining*. **http://wikileaks.org/cable/2008/07/08MUMBAI340.html** [Consulted on 12.10.2012.]

WMO, 1979. *Declaration of the world climate conference*. WMO

WMO, 2012. *World Climate Program*. **http://www.wmo.int/pages/prog/wcp/** [Consulted on: 12.12.2011.]

WMO/UNEP, 1990. *The Second World Climate Conference*. **http://unfccc.int/resource/ccsites/senegal/fact/fs221.htm** [Consulted on: 12.12.2010.]

World Bank, 2011. *Ten Years of Experience in Carbon Finance*. Washington DC.

World Bank, 2012. *State and Trends of the Carbon Market Report 2012*. Washington DC

World Commission on the Ethics of Scientific and Technology (WCEST), (2005), *The Precautionary Principle*. Paris, United Nations Educational, Scientific and Cultural Organization.

World Resource Institute, 2005. *World Greenhouse Gas Emissions: 2005*. **http://www.wri.org/chart/world-greenhouse-gas-emissions-2005** [Consulted on: 12.12.2010.]

Yin, R. K. 2003. *Case study research: Design and methods* (3rd ed.). Applied social research methods series, volume 5. Sage Publishing, Thousand Oak

Personal communications

Baranyay, Dávid. Trader, Major Emission Trading Company. Formal interviews, Budapest 11. November 2011 and 03. April 2013.

Beregszászi, Péter. Green economy development consultant, Hungarian Ministry of National Development. Informal communication – email communications, 12.2012

Feiler, József. Former Head of Climate Unit, Hungarian Ministry of National Development. Formal interviews, Budapest, 07. May 2008 and 12 September 2012.

Herczeg, Sándor. Director, KPMG Energy & Utilities advisory services. Formal interview, Budapest, 6. September 2012

Luttmer, Maxim. Managing Director, BECO Hungary. Formal interview, Budapest, 10 June 2011.

Conferences attended/presented in the field of or related to the research

Conference on the rules of emission trading, 2012. OKTVF conference held in the Ministry of Rural Development, Budapest

Portfolio Green Investment Forum, 2012. Presentation on the evolution of carbon policy, Budapest

VII. Klímaváltozás Energiatudatosság Energiahatékonyság (KLENEN) konferencia, 2012. [*Climate change, energy awareness and efficiency conference*]. Presentation on the new challenges of the EU ETS, Mátrafüred

KPMG News conference, 2012. Presentation on the challenges of the EU ETS, Budapest

EnergoExpo, 2011. Presentation on the challenges of the 3rd phase of the EU ETS, Debrecen

ESZK Conference series, 2011. Presentation of the Think BRIC! Study of KPMG Budapest

IIR Power Plant Conference, 2010. Presentation on biomass use for energy purposes, Budapest

Energy Efficiency and passive house conference and trade fair, 2010. Budapest

Renewable Investment Summit, 2008. Zurich

ETK Energy Efficiency Conference, 2007. Presentation on municipal energy efficiency investments, Budapest

10 Appendices

10.1 MS Excel model developed for the cost benefit analysis of the Hungarian GIS

GIS Block houses phase 1:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
14 600 000 000,00	48 993 288,59	48 000,00	950,00	34 265,00

years
40,00

co2	**1 370 600,00**
per flat	**28,55**
eur/tco2	**35,75**

GIS Block houses phase 2:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
16 400 000 000,00	55 033 557,05	30 000,00	336,00	44 041,00

years
40,00

co2	**1 761 640,00**
per flat	**58,72**
eur/tco2	**31,24**

GIS Climate friendly homes:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
2 000 000 000,00	6 711 409,40	2 000,00	1 191,00	5 128,00

years
40,00

co2	**205 120,00**
per flat	**102,56**
eur/tco2	**32,72**

GIS Energy efficient home appliances:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
1 000 000 000,00	3 355 704,70	11 700,00	195,00	3 830,00

years
15,00

co2	**57 450,00**
per flat	**4,91**
eur/tco2	**58,41**

GIS Light bulbs:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
450 000 000,00	1 510 067,11	20 300,00	257,00	17 681,00

years
5,00

co2	**88 405,00**
per flat	**4,35**
eur/tco2	**17,08**

GIS Our home:

funding		flat	applications	Co2 reduct
Huf	EUR	#	#	ton/year
1 560 000 000,00	5 234 899,33	458,00	422,00	11 500,00

years
25,00

co2	**287 500,00**
per flat	**627,73**
eur/tco2	**18,21**

10.2 Representation of the MS Excel model developed for the case of regional fuel price differences in the power generation sector

	Fuel price (EUR/MWh)	PP Efficiency (%)	Power cost on fuel (EUR/MWh)	Total power cost (EUR/MWh)	emission factor (kg/GJ)	emission factor fuel (t/MWh)	pp emission (t/MWh)
Fuel							
Coal	5,88	40,00%	14,70	36,75	113,32	0,407919366	1,019798416
Natural gas	19	55,00%	34,55	38,38	56,1	0,201943844	0,367170626

CO2 price (EUR/t)	0	10	20	30	40	50	60	70	80	90
Total PP (EUR/MWh)										
Coal	36,75	46,95	57,15	67,34	77,54	87,74	97,94	108,14	118,33	128,53
Natural gas	38,38	42,06	45,73	49,40	53,07	56,74	60,41	64,09	67,76	71,43

Fuel type user	PP fuel cost/total cost (%)
Natural gas	90,00%
Coal	40,00%