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European Union Emissions Trading System (EU ETS) and its contribution to achieving the EU Targets on climate policy

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ABSTRACT OF
MASTER'S THESIS

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Summary
The aim of this research was to investigate the long-run relationship between economic growth and environmental quality through empirical research and use of game theoretic analysis.

Objectives

I) To investigate the contribution of the European Union Emissions Trading System (EU ETS) to the EU Targets achievement;
II) To indicate the role of a market-based mechanism to the mitigation of the bad effects of the Climate Change;
III) To examine whether the market and its laws can be fully substituted for regulation;
IV) To discover the optimum solution to the environmental problem.

Conclusions

I) The mitigation of emissions was due mostly to the decreased economic activity because of the economic crisis rather than to the EU ETS' s contribution;
II) Bad implementation of the EU ETS led to the conclusion that it's an inefficient mechanism;
III) Market-based mechanisms aren't inefficient but have to be regulated so as market failures to be corrected.

Key words: European Union Emissions Trading System (EU ETS), EU Targets, grandfathering, auctioning, carbon leakage, competitiveness, Environmental Kuznets Curve (EKC), Pollution Haven Hypothesis (PHH), game theory, Border Carbon Adjustment (BCA), Best Technology Available (BTA) benchmarks, developed countries, developing countries, economic growth, trade openness.
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LIST OF ACRONYMS AND ABBREVIATIONS

AAU	Assigned Amount Unit
AVR	Accreditation and Verification Regulation
BAT	Best Available Technology
BCA	Border Carbon Adjustment
CA	Competent Authority
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EA	European Cooperation for Accreditation
EC	European Commission
EEA	European Economic Area
EEX	European Energy Exchange
EIB	European Investment Bank
EITE	Energy Intensive Trade Exposed
EKC	Environmental Kuznets Curve
ERU	Emission Reduction Unit
EUA	Emission Unit Allowance
EU ETS	European Union Emissions Trading System
EUTL	European Union Transaction Log
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade
GHG	Greenhouse Gas
ICAO	International Civil Aviation Organization
ICE	ICE Future Europe
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KP	Kyoto Protocol
MAR	Market Abuse Regulation
MBI	Market-based instrument
MiFID2	Directive on Markets in Financial Instruments
MRR	Monitoring and Reporting Regulation
MRV	Monitoring, Reporting, and Verification
MRVA	Monitoring, Reporting, Verification and Accreditation
MSR	Market Stability Reserve
MTOE	Million Tonnes of Oil Equivalent
NAB	National Accreditation Body
NAP	National Allocation Plan
NER	New Entrants Reserve
PAC	Pollution Abatement Costs
PFCs	Perfluorocarbons
PHH	Pollution Haven Hypothesis
PPC	Public Power Corporation
R&D	Researrch & Development
RES	Renewable Energy Sources
TNAC	Total Number of Allowances in Circulation
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organisation

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I. Introduction

In Europe and globally, temperature rises have already led to observable changes in natural systems and society. To avoid dangerous levels of warming, the international community committed to the objective of limiting the mean global temperature rise to well below 2 °C above pre-industrial levels and to drive efforts to limit the increase even further to 1.5°C signing an Agreement at the UNFCCC 21st Conference of the Parties (COP 21) in 2015 in Paris. However, in *2017 edition of the Emissions Gap report* it was stated that *"there is a catastrophic climate gap between where the existing Paris Agreement commitments will get us, and where science says we need to be to limit global warming to less than 2°C"*[1].

Climate change is a global, multidecade challenge and as such it transcends the short-term nature of politics, which inevitably experience changes in priorities, personnel and knowledge. Because of this, climate change cannot be solved by governments alone. Instead, it needs significant and long-term investment on a voluntary basis from the private sector[2]considering that the benefits of avoiding the consequences of climate change far outweigh the costs of reducing greenhouse gas (GHG) emissions. Resources must move freely to where and when it is most needed reaping maximum benefits for society from cross-border competition, providing the right signals and incentives to drive the right investments, fully integrating increasing shares of renewable energies and generally ensuring their most efficient distribution thet would take into account their scarcity. Finally prices must better reflect the actual Demand and Supply situation, internalizing negative externalities like pollution. To this context Adam Smith had proposed as a solution to this problem the idea of an *"invisible hand"* that would represent the tendency of free markets to regulate themselves by means of competition, supply and demand, and self-interest of rational actors[3]. *Market–based mechanisms* are needed to reach the decarbonisation of the global economy in a cost-effective way, to incentivise investments in innovative lean technologies and to phase out carbon support schemes in the long term without compromising system adequacy or security of supply.

As it is thoroughly analysed in the present research, the market represents a tool to help mitigate the causes of climate change putting a price on carbon that reflects the cost of abatement. By being cost-efficient, it allows companies to maximise their ambition and bridge the gap between their internal reductions and more challenging targets such as carbon neutrality.Through the simple process of buying carbon credits, organizations are directing finance to critically challenged economies and ecosystems, as sustainable development outcomes. Companies are looking to differentiate from their competitors, and build their brand, by taking a leadership role on climate. On the contrary, regulatory interventions are only acceptable if and when significant external factors are not sufficiently taken into account or where market failure is feared.

As a means of implementing the international obligations in the EU, the Europe 2020 strategy aims to turn the EU into a so-called 'low-carbon' economy while emphasizing the need of smart, sustainable and inclusive growth in order to improve Europe's competitiveness while reducing the impact on the natural environment. Investing in cleaner technologies and spurring innovation combats climate change and creates new jobs while by the

[1] (United Nations Environment Programme (UNEP), 2017)
[2] (Simon, 2017)
[3] (Smith, 1776)

diversification of energy resources ensures the energy security. The EU ETS is a market-based mechanism designed to focus on the achievement of EU targets defined to this purpose. The present research reviews the impact and future prospects for the EU ETS in meeting the EU Governments' twin objectives of reducing emissions at the lowest cost and setting a carbon price that delivers investment in low-carbon technologies. Despite the fact that emissions trading plays a key role in the grdual decarbonisation of the European economy, some criticism remains. As it is going to be proved market solutions are not the only option. Various *hybrid* schemes designed to combine regulations with competitive markets might serve as effective alternatives.

II. Facing Climate Change

As Nicholas Stern argued in his review *"Climate change is the greatest and widest-ranging market failure ever seen"*[4]. To be more precise, it is not just one market failure but several ones. Firstly, because of the time-inconsistency, what we can do now can only have a limited effect on the climate over the next 40 to 50 years. Through financial investments on mitigation an immediate return is theoretically possible but social benefits can be expected only in the long term while through investments on adaptation immediate social benefits seem possible, but the related return is really uncertain, if any. Moreover transaction costs can be diagnosed, not only financial but also concerning the technical capacity and the regulatory context, as well. What's more the split of incentives and the information asymmetry are the failures mostly observed due to the lack of reliable monitoring of GHG emissions and the absence of strong awareness on the link between them and extreme climate events[5].

1. *The problem of social cost*

Implicit or explicit property rights can be created by regulating the environment, either through prescriptive command and control approaches (e.g. limits on input/output/discharge quantities, specified processes/equipment, audits) or by market-based instruments (e.g. taxes, transferable permits or quotas). As it has been proposed by Ronald Coase, clearly defining and assigning property rights would resolve environmental problems by internalizing externalities and relying on incentives of private owners to conserve resources for the future[6]. At common law nuisance and tort law allows adjacent property holders to seek compensation when individual actions diminish the air and water quality for adjacent landowners. Critics of this view argue that this assumes that it is possible to internalize all environmental benefits, that owners will have perfect information, that scale economies are manageable, transaction costs are bearable, and that legal frameworks operate efficiently.[7]

"The Problem of Social Cost" (1960) by Ronald Coase[8], then a faculty member at the University of Virginia, is an article dealing with the economic problem of externalities. It was cited by the Nobel committee when Coase was awarded the Nobel Memorial Prize in Economic Sciences in 1991. The article is foundational to the field of law and economics, and has become the most frequently cited work in all of legal scholarship. It draws from a number of English legal cases and statutes to illustrate Coase's belief that legal rules are only justified by reference to a cost–benefit analysis, and that nuisances that are often regarded as being the fault of one party are more symmetric conflicts between the interests of the two parties. If there are sufficiently low costs of doing a transaction, legal rules would be irrelevant to the maximization of production. Coase said that regardless the judge's rule, the parties could strike a mutually beneficial bargain about the result of the conflict that reaches the same outcome of productive activity. However, many welfare-maximizing reallocations are often forgone because of the transaction costs involved in bargaining.[9] Because in the real world there are costs of bargaining and information gathering, the so-called transaction costs, legal rules are justified to the extent of their ability to allocate rights to the most

[4] (Stern, 2007)
[5] (Union for the Mediterranean, 2016)
[6] (Coase, 1960)
[7] (Guerin, 2003)
[8] (Coase, 1960)
[9] (McGaughey, 2013)

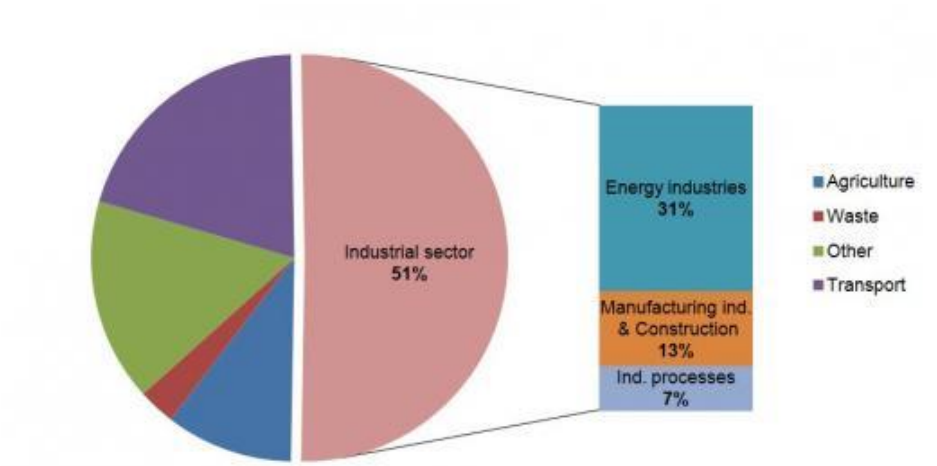
efficient right-bearer. In cases with potentially high transaction costs, the price signals that would have led to the most efficient distribution of resources, are ultimately postponed. The law ought to produce an outcome similar to what would result if the transaction costs were eliminated, providing a fair compensation to the party whose right has been affected duo the above market failure. Hence courts should be guided by the most efficient solution.

Coase and others like him wanted a change of approach, to put the burden of proof for positive effects on a government that was intervening in the market, by analysing the costs of action.[10] Guido Calabresi in his book 'The Costs of Accidents' argued that it is still efficient to hold companies liable that produce greater wealth[11]. In the real world, where people cannot negotiate costlessly, there may be collective action problems of those who caused a nuisance, for instance by smoke emissions from a factory to many neighbouring farms, and so getting together to negotiate effectively can be difficult against a single polluter because of coordination problems (see Section VI.3). If it is efficient for the farmers to pay the factory to reduce its emissions, some of those farmers may hold off paying their fair share, hoping to get a free ride. The factory may be in a better position to know what measures to take to reduce harm, and can be the cheapest avoider, illustrating Coase's argument[12]. The ultimate thesis, as expressed by Henry Smith and Thomas Merrill, is that law and regulation are not as important or effective at helping people as lawyers and government planners believe.[13]

Industrial activities, i.e. mining and quarrying, manufacturing, electricity, water, and gas supply, according to OECD definition[14] , have a significant contribution to the GDP of the European Union (EU), currently accounting for 24.3%. Industrial activity accounts for over 20% of GDP in 85% of EU-28[15]. As a result, greenhouse gas emissions generated by industrial activity constitute a considerable share of total emissions in the EU. More specifically industrial emissions account for a share exceeding 50% (see Figure 1).[16]Industry fears a high burden under the proposed regulated targets and actively opposes them.[17]

[10] (Pigou, 1920)
[11] (Calabresi, 1970)
[12] (Coase, 1960)
[13] (Smith & Merrill, 2017)
[14] (OECD)
[15] (World Data Bank , 2013)
[16] (Eurostat, 2011)
[17] (climatepolicyinfohub.eu)

Figure 1: Industries responsible for over 50% of all EU-28 GHG emissions in 2011



Source: Eurostat, Greenhouse gas emissions by sector (2011), European Environment Agency, https://climatepolicyinfohub.eu/role-industrial-emissions-within-eu-trends-and-policy

A. *Externalities' internalization*

The externality is defined as a cost or benefit generated by an economic activity which affects an unrelated third party. An externality can be positive (a benefit, such as the learning effects generated by the introduction of new technologies to a new market) or negative (a cost, such as the cost generated to nearby residents by industrial pollution).[18] As an external cost, the externality isn't included in the price of the generated products and as a result the price signals conveyed to consumers lead to an inefficient allocation of scarce resources, a fact that proves that markets do fail, if certain conditions are not met. By internalizing the externalities, the matket failure is corrected and the market functions properly, so as to secure the most efficient allocation of natural resources.

In the specific case of GHG emissions, by pricing carbon, the external cost of industrial pollution, as an externality and according to some scientists[19] as the fundamental factor of Climate Change, is finally internalized conveying the right price signals to consumers, i.e. emitting GHG emissions is not neutral, and solving the split of incentives while at the same time unlocking market barriers through the requested raising of revenues.[20]

Raising the price of carbon will achieve four goals. First, it will provide signals to consumers about what goods and services are high-carbon ones and should therefore be used more sparingly. Second, it will provide signals to producers about which inputs use more carbon (such as coal and oil) and which use less or none (such as natural gas or nuclear power), thereby inducing firms to substitute low-carbon inputs for high-carbon ones. Third, it will give market incentives for inventors and innovators to develop and introduce low-carbon products and processes that can replace the current generation of technologies. Fourth, and most important, a high carbon price will economize on the information that is required to do all three of these tasks. Through the market mechanism, a high carbon price will raise the price of products according to their carbon content. Ethical consumers today, hoping to minimize their "carbon footprint," have little chance of making an accurate

[18] (climatepolicyinfohub.eu)
[19] (Stern, 2007)
[20] (Union for the Mediterranean, 2016)

calculation of the relative carbon use in, say, driving 250 miles as compared with flying 250 miles. A harmonized carbon cost would raise the price of a good proportionately to exactly the amount of CO_2 that is emitted in all the stages of production that are involved in producing that good. The “carbon footprint” is automatically calculated by the price system. Consumers would still not know how much of the price is due to carbon emissions, but they could make their decisions confident that they are paying for the social cost of their carbon footprint. [21]

B. Setting a market price for carbon

In his article ‘Carbon trading: Where greed is green’ James Kanter presents the case of Louis Redshaw, a former electricity trader, who met with five top investment banks to propose trading carbon dioxide, seeking to match a desire to make money with his environmental instincts. Only one, Barclays Capital, was interested in his proposition.Three years later, the situation has turned around entirely, and carbon experts like Redshaw, are among the rising stars in the City of London financial district. Redshaw, being the head of environmental markets at Barclays Capital stated: *“Carbon will be the world's biggest commodity market, and it could become the world's biggest market overall”*. According to Kanter, if greed is suddenly good for the environment, then the seedbed for this vast new financial experiment is London. The rapid emergence of carbon finance in London not only trading carbon allowances but investments in projects that help to generate additional credits is largely the result of a decision by European governments to start capping amounts that industries emit. Factories and plants that pollute too much are required to buy more allowances; those that become more efficient can sell allowances they no longer need at a profit. As Chris Leeds, the head of emissions trading at Merrill Lynch in London has mentioned managing emissions is one of the fastest-growing segments in financial services, with volumes comparable to credit derivatives inside of a decade. [22]

Kanter poited out that Wall Street firms like Cantor Fitzgerald with its environmental subsidiary Cantor CO2, were the first ones which successfully using markets reduced industrial pollutants that caused acid rain in North America, and begun investing in credit-generating projects but New York lost its lead in carbon finance after President George W. Bush refused to ratify the Kyoto Protocol in 2001. *“Technically U.S. companies had the expertise and then the Europeans really delivered”* said Garth Edward, the trading manager for environmental products in London at Shell Trading, a unit of the oil company Shell, who formerly worked in New York for Natsource, one of the first greenhouse gas brokerages.[23]

Carbon credits create a market for reducing GHG emissions by giving a monetary value to the cost of polluting the air. Emissions become an internal cost of economic activity appearing on the balance sheet exactly as raw materials and other liabilities or assets. Yale University economics professor William Nordhaus in his research is looking for the *“optimal”* policy, meaning the one that sets emissions reductions to maximize the economic welfare of humans.The social cost of carbon is the additional damage caused by an additional ton of carbon emissions. In Nordhaus’s point of view the optimal carbon price is the market price on carbon emissions that balances the incremental costs of reducing carbon emissions with the incremental benefits of reducing climate damages. In his research he argues that the

[21] (Nordhaus, 2008)
[22] (Kanter, 2007)
[23] (Kanter, 2007)

price of carbon needs to be high enough to motivate the changes in behavior and changes in economic production systems necessary to effectively limit emissions of greenhouse gases. As he has suggested, based on the social cost of carbon emissions, an optimal price of carbon is around $30 (US) per ton and will need to increase with inflation. According to his findings this policy reduces the global temperature rise relative to 1900 to 2.6°C in 2100 and to 3.4°C in 2200 and its net present-value benefit is $3 trillion while the global abatement costs'one would be around $2 trillion, which is 0.1 percent of discounted world income. If concentration or temperature limits are added to the economic optimum, the additional cost is relatively modest for all but the most ambitious targets. Although the net impact of policies is relatively small, the total discounted climatic damages are large. [24]

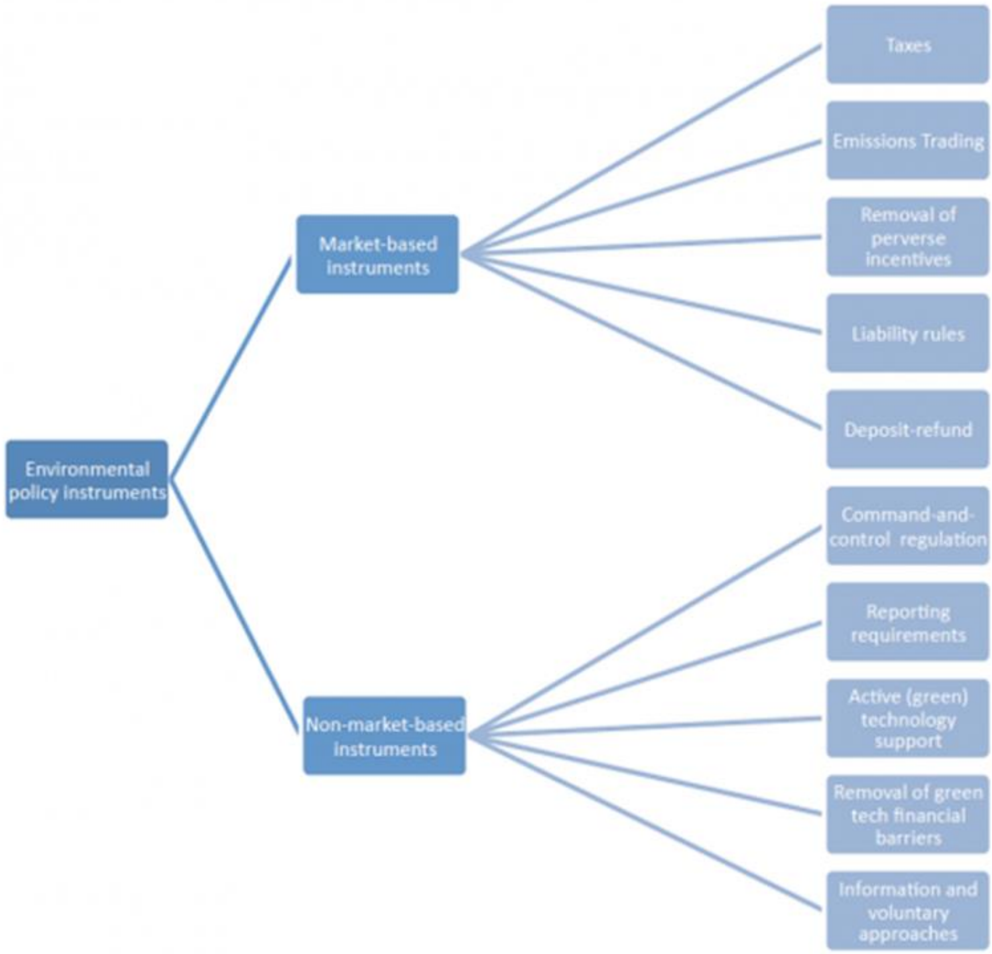
2. *Key strategies: Regulation vs Market based mechanisms*

The main instrument categories applied within the climate policy mix include non-market-based and market-based instruments. According to Benjamin Görlach's distinction *non-market based instruments* (N-MBIs) work through the imposition of certain obligations or by installing non-monetary incentives to change behavior whereas *market-based instruments* (MBIs) are indirect regulatory instruments, which influence actors' behaviour by changing their economic incentive structure[25]. Both instrument types have specific characteristics and thus certain advantages and disadvantages. Due to their complementary characteristics, diversity within the policy instruments can effectively combine environmental and economic motivations. Smart policy design should take the respective characteristics of the different policy types into account and choose the most suitable policy based on the function it is meant to fulfil – in the respective context. A hybrid policy approach can thereby reduce short-comings of each single instrument and lead to an improved outcome in comparison to the introduction of a single policy type. Simultaneous application of various policy instruments can have synergetic but also contradictory effects, considering that the exploitation of the theoretical potential of policy instruments depends on the final details in policy design and its implementation.There is no agreed set of criteria to evaluate climate policy instruments that is universally accepted. Often policies are evaluated with a bias towards the concept of present cost minimisation (static efficiency).[26] However, it can be argued that a broader evaluation framework is necessary, including three main criteria, which influence practical feasibility; these criteria are environmental effectiveness, cost effectiveness and additional impacts on society, e.g. income distribution or employment.[27]

Figure 2 depicts a general taxonomy of climate policy instruments based on a categorisation produced under the research project *CECILIA 2050*[28].This section will give a short introduction to each instrument category.

[24] (Nordhaus, 2008)
[25] (Görlach, 2013)
[26] (climatepolicyinfohub.eu)
[27] (Görlach, 2013)
[28] (Görlach, 2013)

Figure 2: Taxonomy of climate policy instruments



Source: Görlach, Benjamin, "What constitutes an optimal climate policy mix? Defining the concept of optimality, including political and legal framework conditions", CECILIA2050 Deliverable 1.1, (Berlin: Ecologic Institute, February 2013), online available at: http://cecilia2050.eu/system/files/G%C3%B6rlach%20%282013%29_What%20cons...

A. Non-Market-Based Climate Policy Instruments

Non-market-based climate policy instruments may function in the more appropriate way in terms of environmental effectiveness but when they are implemented in their proper form, they may fall short in cost-effectiveness, as a result of their specific characteristics.

i. Command-and-control regulations

An alternate much more prescriptive than market-based instruments approach to environmental regulation is a command and control approach. Command and control approaches have been criticised for restricting technology, as there is no incentive for firms to innovate. However, they may be beneficial as a starting point, when regulators are faced with a significant problem yet have too little information to support a market-based instrument. Command and control approaches can also be preferred when regulators are faced with a thin market, where the limited potential trading pools mean the gains of a market-based instrument would not exceed the costs (a key requirement for a successful market-based approach).[29]

In climate change policies, command-and-control regulation is a direct mean of addressing GHG emissions or energy efficiency. Standards are usually combined with legal enforcement in the case of non-compliance. They are a very straight-forward way of policy intervention with relative certainty over the environmental effectiveness[30]. However, considering the varying costs of possible GHG abatement measures, a direct intervention might not result in the most cost-effective measures being introduced. Moreover, if applied alone a purely regulatory approach might have to become increasingly intrusive to address possibly occurring rebound effects[31].Nevertheless, command-and-control measures can play an important role in innovation and technology development. By supporting and developing currently not profitable technologies, the range of available abatement options can be increased by bringing these technologies to market maturity. Together with price mechanisms, command-and-control can create a market for new technologies[32] [33].

Command-and-control regulatory instruments include emissions standards, process/equipment specifications, limits on input/output/discharges, requirements to disclose information, and audits. They impose direct regulatory intervention by setting standards, e.g. of pollution output or technology requirements. Forms of command-and-control instruments mainly comprise framework, performance and technology standards, as well as prohibition of certain products and practices[34]. Performance standards (also referred to as minimum energy performance standards or benchmarks) aim at a specific environmental target without prescribing which technology needs to be used[35]. An example of a performance standard in the EU is the 2009 regulation on the reduction of CO_2 emissions of new passenger cars[36]. Thus, producers are forced to produce cars that match these regulations. Technology standards prohibit or phase out certain technologies that are environmentally harmful or set minimum standards. The Directive on Industrial Emissions, for example, (integrated pollution prevention and control) (IED)[37], requires that industrial activities with a major pollution potential must meet certain obligations, e.g. reduce emissions, reduce and recycle waste or maximise energy efficiency. One qualitative basis for the assessment under this directive is the framework standard BATNEEC (best available technology not entailing excessive cost) as required by Article 13(1) of the IED, which introduces a moving target on applied technologies and practices, since technological standards and societal values might change.[38]

ii. Reporting Requirements

Introducing a reporting requirement is a non-market based instrument that is often the basis for future legislation or forms part of other instruments. It aims at increasing the level

[29] (Guerin, 2003)
[30] (Common & Stagl, 2009)
[31] (Grubb , et al., 2014)
[32] (Grubb , et al., 2014)
[33] (climatepolicyinfohub.eu)
[34] (Görlach, 2013)
[35] (Görlach, 2013)
[36] (EUROPEAN PARLIAMENT & COUNCIL, 2014, pp. 15-21)
[37] (EUROPEAN PARLIAMENT & COUNCIL, 2010)
[38] (climatepolicyinfohub.eu)

of information available to a governmental body. However, it can also serve to increase awareness, even through the effort of acquiring the additional information, for instance in the case of measuring emissions of an environmental pollutant, which otherwise literally goes out through the chimney without the plant operator taking particular notice[39]. Reporting requirements are often included into further legislation that accompanies the single policy instruments, such as the Renewable Energy Directive or the Energy Efficiency Directive. An example is the Monitoring Mechanism Regulation (MMR), setting reporting rules on GHG emissions to meet international requirements and reporting obligations form the 2009 climate and energy package. It helps to keep track of progress towards meeting the Member States' emission targets for 2013-2020 and thereby facilitates further development of the EU climate policy mix.[40]

iii. Active (green) technology support

Active green technology support is the public promotion of research and development on green technology or of the adoption of green technology. These instruments focus on the supply side of green technology, as they aim at improving its availability and deployment. Although these instruments involve market elements to a varying degree, they usually involve strong regulatory intervention and have marked technology specifications. Measures include the funding of public and private research, development and demonstration (RD&D), infrastructure funding, and public procurement. Examples include the NER 300 programme funding innovative carbon capture and storage (CCS) and renewable energy demonstration projects. The subsidies for RES and the renewable energy support schemes, such as quota obligations or feed-in tariffs also belong to this category[41] [42].

iv. Removal of green-tech financial barriers

These are demand side measures to support the use of climate friendly products and practices. Support can be given via tax reductions or tax breaks, capital allowances, direct payments or subsidised loans. Also here the instruments incorporate economic incentives but they incentivise highly specific technology applications instead of influencing energy product prices or GHG emissions per se and are therefore listed as non-market-based. This includes examples such as capital allowances for investment in energy efficient equipment in the United Kingdom (UK) or sponsored loans and grants for homeowners who improve their building's energy efficiency[43].

v. Information and voluntary approaches

This group of instruments influences the actions of societal actors through their moral sense and by changing the cultural environment. Hence, these instruments influence actors

[39] (Görlach, 2013)
[40] (climatepolicyinfohub.eu)
[41] (Görlach, 2013)
[42] (climatepolicyinfohub.eu)
[43] (climatepolicyinfohub.eu)

indirectly by means of information, awareness raising and setting of moral standards. Typical examples are product labelling, voluntary agreements with polluters, award schemes or public information campaigns.

- Environmental product labelling aims to give consumers access to information on the environmental performance of the product to put them into position to include environmental characteristics in consumption decisions. The labels can contain information on product content, composition, and its origin or production method[44].
- In the 1990s, voluntary agreements between governments and companies aiming at the reduction of GHG emissions were introduced in various Member States in sectors such as industry, agriculture and transport. In general, signatories of voluntary agreements either committed to carrying out a specific action that is supposed to reduce their environmental impact (e.g. energy audits) or the signatories agree to meet general targets. Tax rebates often play a role in incentivising the signatories to commit to voluntary agreements. Examples of voluntary agreements entail energy audits, benchmarking, action plans and energy management systems[45]. Often, a voluntary agreement is the first step in tackling a policy problem, where industries are reluctant to change behaviour. The Regulation on car emissions[46] is an example, where first voluntary agreements on vehicle emission standards were arranged with the automobile industry, which later were substituted by a regulation.
- Public information campaigns can raise awareness of environmental concerns and policy initiatives. European historic examples include *"You Control Climate Change"* or *"A world you like. With a climate you like"*[47].

B. Market-Based Climate Policy Instruments

In environmental law and policy, *Market-Based Instruments* (MBIs) are indirect regulatory instruments, which influence actors' behaviour by changing their economic incentive structure. Costs from environmental externalities, such as greenhouse gas (GHG) emissions, are usually not reflected in consumption or investment decisions but are nonetheless imposed on third parties. MBIs are policy instruments that use markets, price, and other economic variables to signal and incentivise the polluters to reduce or eliminate negative environmental externalities. MBIs seek to address the market failure of externalities (such as environmental pollution from GHG emissions) by incorporating the external cost of production or consumption activities to the price of the original emitting process through taxes or charges on processes or products, or by creating property rights and facilitating the establishment of a proxy market for the use of environmental services.

MBIs differ from other policy instruments such as voluntary agreements (actors voluntarily agree to take action) and regulatory instruments called *"command-and-control"* in case of which public authorities mandate the performance to be achieved or the technologies to be used. However, implementing a MBI also commonly requires some form

[44] (Common & Stagl, 2009)
[45] (European Commission, 2010)
[46] (EUROPEAN PARLIAMENT & COUNCIL, 2014, pp. 15-21)
[47] (climatepolicyinfohub.eu)

of regulation corrective of distortions that may occur in case market fails. MBIs can be implemented in a systematic manner, across an economy or region, across economic sectors, or by environmental medium (e.g. water). Individual ones are instances of environmental pricing reform.

Although the use of new environmental policy instruments only grew significantly in Britain in the 1990s, David Lloyd George may have introduced the first market-based instrument of environmental policy in the UK when a Fuel tax was levied in 1909 during his ministry.[48] For a variety of reasons, environmental advocates initially opposed the use of market-based instruments except under very constrained conditions. However, after the successful use of freely traded credits in the lead phasedown in the U.S. environmental advocates recognized that trading markets has benefits for the environment as well. Thereafter, beginning with the proposal of the acid rain allowance market, environmental advocates have supported the use of trading in a variety of contexts. [49]According to Nancy Kete *"policymaking appears to be in transition towards more market-oriented instruments, but it remains an open-ended experiment whether we shall successfully execute a long-term social transition that involves the private sector and the state in new relationships implied by the pollution prevention and economic instruments rhetoric"*.[50]

Market-based instruments do not prescribe that firms use specific technologies, or that all firms reduce their emissions by the same amount, which allows firms greater flexibility in their approaches to pollution management. Market-based instruments have a high distributional impact. Pricing instrumentsideally perform well in terms of (static) cost-effectiveness. Their revenue (where such is generated) can also help fund other policy programmes. However, applied alone they would likely require very high price levels to trigger desired changes and they could have a negative effect on low-income households and vulnerable industry sectors[51]. Furthermore, humans do not always respond to price signals in the desired way; reaction can also lag behind for a certain time span. Given incumbent interests and technology lock-in effects, market-based instruments alone are likely to not provide sufficient incentives for innovation and innovation diffusion[52]. Market-based instruments may also be inappropriate in dealing with emissions with local impacts, as trading would be restricted to within that region. They may also be inappropriate for emissions with global impacts, as international cooperation may be difficult to attain.

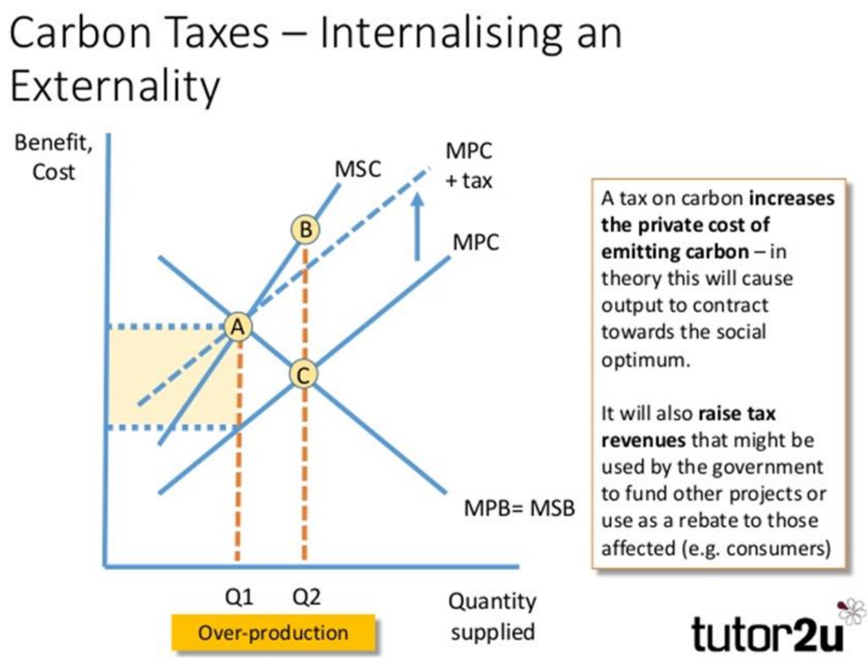
To conclude, market-based climate policy instruments may function in the more appropriate way in terms of cost effectiveness but when they are implemented in their proper form, they may face problems of acceptance and environmental effectiveness, as a result of their specific characteristics. As market-based mechanisms, they are also in danger of market failures such as time-inconsistency, transaction costs, information asymmetry and split of incentives. A combination with command-and-control tools and dedicated technology support might therefore be necessary.

i. Carbon taxes

[48] (Jordan, et al., 2003)
[49] (Alan , 1995)
[50] (Kete, 1994)
[51] (Grubb , et al., 2014)
[52] (climatepolicyinfohub.eu)

As it can be assumed through a global overview of carbon pricing, the carbon tax is ranked at the first place between the most popular policy instruments used in different countries against the negative effects of global warming. A CO2 tax, as climate pollution tax was first introduced in Sweden in 1991 but soon was imposed by the government of India (2010) and Chile (2014). Australia repealed its carbon tax in 2014 and Alberta (Canada) started a new carbon tax while Iceland announced intention to double carbon tax in 2017. Finally Singapore plans to introduce a carbon tax in 2019.[53]

The idea of environmental taxation was first introduced by Arthur Cecil Pigou, which is why these taxes are sometimes also referred to as Pigouvian taxes. Pigou in his book 'The Economics of Welfare' [54]providing a solution to the much discussed problem of externalities associated with market inefficiencies, introduced the idea of a tax to reduce negative side-effects of economic activities on humans, such as environmental pollution. Environmental taxes add directly to the price of a certain good or service, which ideally should reflect the environmental externalities caused by production and/or consumption of this good or service. The rise in costs is usually passed through the tax to the end consumer, so that the negative impact of pollution can be reduced in a way that harms consumers and industry as little as possible while maximizing social welfare. In theory, the consumer reacts with a reduction of demand, as the price increases. However, consumer reactions are hard to predict and depend on availability of substitutes and perceptibility of the price signal[55]. As a tax fixes a price and thereby indirectly influences behaviour, it is therefore also crucial to set the price at the right level. If the carbon tax is set too low, the abatement measures will be also low. For these reasons environmental taxes bear a certain degree of uncertainty regarding their environmental effectiveness.



Graph 1: Carbon Taxes – Internalising an externality
Source: Evaluating Policies to Cut Carbon Emissions, A Level Economics Revision, April 2017, available at: https://www.slideshare.net/tutor2u/evaluating-carbon-policies

[53] (tutor2u, 2017)
[54] (Pigou, 1920)
[55] (climatepolicyinfohub.eu)

More specifically a market-based tax approach determines a maximum cost for control measures. This gives polluters an incentive to reduce pollution at a lower cost than the tax rate. A pollution tax internalizes the externality and makes the polluter pay in a fairly easy to administer and predictable way. Taxes have lower compliance costs than permits and as a result they are more flexible than them. As it appears above on the Graph 1, an imposed tax increasing the private cost of emiting carbon leads to a shift of the Marginal Propensity to Consume (MPC) curve to the left. As there is no cap, the quantity of pollution reduced depends on the chosen tax rate. The tax rate can be adjusted until the output contracts towards the social optimum creating the most effective incentive. However in the case of a Pigouvian tax, the actual amount of achieved emissions reduction is a priori unknown due to unknown marginal abatement costs of polluters. [56]In addition, a carbon fee on imported products reduces risk of domestic businesses relocating to avoid paying a national carbon tax while it raises governmental revenues, which can be earmarked for other uses such as subsidies for Research & Development (R&D), the backbone of clean energy innovation[57].

Furthermore, environmental taxes change the relative values of input factors in the economy. When energy prices rise, this means that relatively labour becomes cheaper. If revenues are additionally spent on tax reductions in other areas, such as labour, this effect even multiplies. The tax therefore has the potential to produce a so called *"double dividend"*, i.e. tackling environmental problems and reduce taxation in other areas. However, it is a fundamental characteristic of an effective environmental tax that its tax base will erode. Moreover, environmental taxes tend to have negative distributional effects, since lower income households are generally more affected and might also be more limited in the substitution options available to them[58]. In this context, offsetting tax cuts or tax rebates can also be provided for lower-income or weaker population groups.[59] Using a tax potentially enables a double dividend, by using the revenue generated by the tax to reduce other distortionary taxes through revenue recycling.[60]

However, taxes are less effective at achieving reductions in target quantities than permits because of their low price elasticity of demand. In contrast to other more effective alternative policies on offer, the tax may not change behavior. Moreover, the competitiveness of domestic businesses in overseas markets might be damaged. As renewables employ relatively few people, there is always the risk of higher structural unemployment among workers in carbon intensive sectors such as mining, oil and gas. The risk of a heavier burden of new / higher carbon taxes on lower-income families can't either be underestimated.[61] Even worse, there can be conflict between objectives with a tax considering that less pollution means less revenue.[62]What's more, through the use of carbon taxes as a policy instrument to combat global warming at a national level, there are no transboundary measures'guarantees and environmental integrity is uncertain. In this context he main drawback to use taxes as a

[56] (Heindl & Löschel, 2012)
[57] (tutor2u, 2017)
[58] (Common & Stagl, 2009)
[59] (tutor2u, 2017)
[60] (Guerin, 2003)
[61] (Union for the Mediterranean, 2016)
[62] (tutor2u, 2017)

climate policy instrument on the European level is the need for consensus between Member States regarding their introduction, as well as the detailed policy design e.g. tax rates and tax bases. As this consensus is very hard to achieve, environmental taxation so far has proven to be a policy instrument with low practical feasibility at the European level. Finally issues such as the earmarking of tax revenues and the risk of carbon leakage are of extreme importance but are also arising in the case of emissions trading.

The most relevant environmental taxes in the EU are excise duties on energy products (used for stationary purposes and for transport) and vehicle taxation.The EU determines minimum tax rates for energy products used for heating, as a fuel or as electricity in the Energy Taxation Directive[63]. However, many Member States apply exemptions or reductions. Moreover, these minimum tax rates are not based on the carbon content of the fuels but mainly on weight or volume[64]. However, some Member States apply an explicit carbon tax on top of the regular energy excise duties. In 2012, energy taxes accounted for 75% and transport taxes for 21% of environmental tax revenues in the EU[65].

ii. Emissions trading

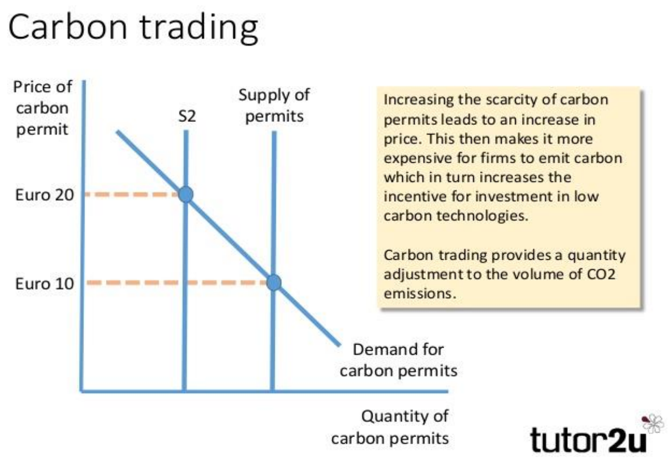
As it can be assumed through a global overview of carbon pricing, the emissions trading mechanism is gaining ground over the carbon tax as a policy instrument used in different countries against the negative effects of global warming. In European Union emissions trading scheme (ETS) began in 2005. South Korea introduced carbon emissions trading in 2015 and China launched an emissions cap & trade system in 2017[66].

Emissions trading can be regarded as the counterpart of a Pigouvian tax on emissions. Cap and trade systems, like taxes, generate economic incentives to change the behaviour of societal actors and reduce pollution. But instead of introducing a fixed price which is added on the price of a certain good or service, the starting point in a cap and trade system is a limit on the physical emission quantity (cap) of a harmful substance, introduced exogenously by a policy maker, the competent regulatory authority, which issues emission allowances or permits to each unit of the pollutant according to the maximum limit it has defined[67]. The emission allowances can be traded freely between regulated firms on a market and polluters can buy and sell them according to their needs, with the allowance price for each unit of emissions determined by the gap between supply and demand[68]. The demand is usually the real GHG emissions and the supply is the amount of the issued emissions allowances. Regulator must define who is committed to surrender them. The offer can be either capped ex ante (ex.EU-ETS) defined according to a benchmark (baseline and credit system) or uncapped (ex.CDM), either allocated for free by grandfathering according to certain criteria, such as past pollution or not (e.g. auctioning). Auctioning generates revenues for the governments that can be used to the reduction of distortionary taxes and to the improvement

[63] (EC, 2003)
[64] (European Commission, 2011)
[65] (Eurostat)
[66] (tutor2u, 2017)
[67] (climatepolicyinfohub.eu)
[68] (Heindl & Löschel, 2012)

of the overall efficiency[69]). [70] These revenues can be counted as the product of the market carbon price multiplied with the fixed volume of GHG emissions[71].

As it appears on the Graph 2, increasing the scarcity of carbon permits by shifting the supply curve to the left leads to an increase in price and this makes it more expensive for firms to emit carbon, which in turn increases the incentive for investment in low carbon technologies. Polluters carry out mitigation actions until it is cheaper to buy an allowance on the market than to mitigate a further emission unit. As a result, those polluters with the cheapest mitigation options will reduce the most. This theoretically guarantees the most cost effective mitigation pathway for society[72].



Graph 2: Carbon trading
Source: Evaluating Policies to Cut Carbon Emissions, A Level Economics Revision, April 2017, available at https://www.slideshare.net/tutor2u/evaluating-carbon-policies

Cap and trade systems are in theory more dependable than taxes since emissions are capped. However, in real applications market design can become very complex. Furthermore, the demand for allowances also depends on the economic situation. In a recession economic activity will decrease and thereby emissions. The decreased demand of allowances will drive down allowance prices. The low allowance price will not serve as an incentive to mitigate emissions investing in low carbon technologies and which can create a lock-in effect, as no further action is required to achieve the emission cap. This can make future emission reductions more expensive, threatening the theoretical cost-effectiveness of an emissions trading system (ETS)[73].

When using a transferable-permit system, it is very important to accurately measure the initial problem and also how it changes over time. This is because it can be expensive to make adjustments (either in terms of compensation or through undermining the property rights of the permits). In addition, as a MBI, emissions trading performs very well in terms of cost-effectiveness; emissions reduction will take place only where it is the cheapest option for the producers to invest in cleaner technology. Permits' effectiveness can only be affected by things like the quality of the property right, existing market power and market liquidity, as they only work on a large scale. An argument against permits is that formalising emission rights is effectively giving people a license to pollute, which is believed to be socially unacceptable. However, although valuing adverse environmental impacts may be controversial, the acceptable cost of preventing these impacts is implicit in all regulatory

[69] (DeBord, 2015)
[70] (Union for the Mediterranean, 2016)
[71] (Union for the Mediterranean, 2016)
[72] (Common & Stagl, 2009)
[73] (climatepolicyinfohub.eu)

decisions.[74] Another important aspect of transferable permits is whether they are auctioned or allocated via grandfathering.

iii. Removal of perverse incentives

This instrument refers to the removal of subsidies for environmentally harmful activities and products, such as subsidies for the extraction or production of fossil fuels, exemptions from energy taxes, or fossil fuel subsidies to keep the price level low. Furthermore, this also includes the removal of further incentives rewarding harmful activities, such as the abolition of liability exemptions[75]. Regarding the extent of these so called perverse incentives, the environmental impact of their abolishment can be potentially large. [76]In 2012, total support provided by EU Member States to coal power generation (hard coal and lignite) summed up to some EUR 10 billion (not including historic support), improving the profitability of the investment, mainly in the form of investment grants, exemptions from fuel taxes and support to decommissioning and waste disposal. Meanwhile total external costs of coal power generation are estimated at EUR 86 billion[77]. Greece and its lignite model was particularly influenced by this specific polisy instrument and its removal, as a measure offering perverse incentives.

iv. Others

Furthermore, there are liability instruments which as described by Gorlach *"impel concerned parties to internalize external costs through the threat of consequential costs"*[78]. Deposit refund systems charge consumers an upfront payment for improper waste disposal. The refund is a reward for returning the waste to the right collection point.

C. Carbon taxes compared to cap-and-trade – An Hybrid approach

Both cap-and-trade and carbon taxes give polluters a financial incentive to reduce their GHG emissions. The basic difference between a tax and an emissions trading scheme is that in the case of a tax a specific price per unit of emissions is fixed and announced by policy-makers, whereas in the case of an emissions trading scheme, a specific quantity of allowed GHG emissions is ex-ante fixed and set by policy-makers[79]. The carbon revenue transfers are the total amounts of money transferred from cosumers to producers, if permits are allocated to producers or to governments, if constraints are imposed through efficient carbon taxes. The redistribution of income is a substantial fraction of world consumption, particularly for the ambitious plans. [80] In Nordhaus' point of view a tax approach can capture the revenues more easily than quantitative approaches with grandfathered permits[81]. According to Matthew DeBord if the revenues are used to reduce other distortionary taxes, this can improve the efficiency of the tax. On the other hand, a cap with grandfathered permits can have an efficiency advantage of being applied to all industries providing an equal

[74] (Guerin, 2003)
[75] (Görlach, 2013)
[76] (climatepolicyinfohub.eu)
[77] (Alberici , et al., 2014)
[78] (Görlach, 2013)
[79] (Heindl & Löschel, 2012)
[80] (Nordhaus, 2008, p. 202)
[81] (Nordhaus, 2008, p. 203)

incentive at the margin for all polluters to reduce their emissions. This is an advantage over a tax that exempts or has reduced rates for certain sectors.[82]

The relative advantages of price-type and quantity-type approaches, are thoroughly examined in William Nordhaus' research. One advantage of price-type approaches is that they can more easily and flexibly integrate the economic costs and benefits of emissions reductions, whereas the approach in the Kyoto Protocol has no discernible connection with ultimate environmental or economic goals. This advantage is emphatically reinforced by the large uncertainties and evolving scientific knowledge in this area. Emissions taxes are more efficient in the face of massive uncertainties because of the relative linearity of the benefits compared with the costs. A related point is that quantitative limits will produce high volatility in the market price of carbon under an emissions-targeting approach[83]. In addition, the tax approach provides less opportunity for corruption and financial finagling than quantitative limits because the tax approach creates no artificial scarcities to encourage rent-seeking behavior. On the other hand carbon taxes appear to be disadvantageous because they do not impose hard constraints on emissions, concentrations, or temperature change. Nordhaus argues that this is largely an illusory disadvantage, as in this field there are great uncertainties about what emissions or concentrations or temperature would actually lead to the dangerous interferences—or even if there are dangerous interferences. [84]

To sum-up, carbon taxes provide certainty regarding emission prices, while a cap provides certainty regarding emissions quantity. In the absence of uncertainty these two systems will achieve the same effect and result in the efficient market quantity of CO_2 and price charged per unit of CO_2 emitted. According to scientific research, in the case of environmental uncertainty, that is when the environmental damages of each unit of CO_2 cannot be accurately calculated, a permit system may be more advantageous in order to limit total quantity and thus potential damages. In the case of uncertainty regarding the costs of CO_2 abatement for firms, a tax is preferable.[85] [86] The abatement uncertainty issue was illustrated in 2005 by the first phase of the EU ETS.

In his research William Nordhaus was wondering: *"Which of the policy approaches would allow flexibility in changing policies as new evidence becomes available? Would it would prove easier to make periodic large adjustments to incorrectly set harmonized carbon taxes or to incorrectly negotiated emissions limits?"* He concludes suggesting that a hybrid approach, which he calls "cap and-tax," might combine the strengths of both quantity and price approaches. An example of a hybrid plan would be a traditional cap-and-trade system combined with a base carbon tax and a safety valve available at a penalty price. For example, the initial carbon tax might be $30 per ton of carbon, with safety-valve purchases of additional permits available at a 50 percent premium.[87] A hybrid instrument of a cap and carbon tax can be made by creating a price-floor and price-ceiling for emission permits. [88]

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[82] (DeBord, 2015)
[83] (Nordhaus, 2008, p. 202)
[84] (Nordhaus, 2008, p. 203)
[85] (Center for Climate and Energy Solutions, 2017)
[86] (Grantham Research Institute on Climate Change and the Environment, London School of Economics, 2014)
[87] (Nordhaus, 2008, p. 203)
[88] (Greenbaum, 2010, pp. 240-241)

III. Choosing a market-based mechanism to mitigate pollution

A financial mechanism can be established to overcome market failures such as the negative externality of environmental pollution, time-inconsistency, transaction costs and a split of incentives, already above outlined as the main attributes of the climate change. Carbon pricing is a market-based mechanism, which as a policy instrument uses markets, price, and other economic variables to provide incentives for polluters to reduce or eliminate negative environmental externalities in a cost-effective way. However, adopting all the characteristics of a market this policy instrument is itself threatened during its implementation by another kind of market failure, extensively known in financial markets, the market abuse.

1. *Property rights*

Property rights are theoretical socially-enforced constructs in economics for determining how a resource or economic good is used and owned[89]. Property rights can be viewed as an attribute of an economic good. This attribute has four broad components[90] and is often referred to as a bundle of rights: the right to use the good, the right to earn income from the good, the right to transfer the good to others and the right to enforce property rights[91]. In economics, property is usually considered to be ownership (rights to the proceeds generated by the property) and control over a resource or good. Many economists effectively argue that property rights need to be fixed and need to portray the relationships among other parties in order to be more effective[92].

Classical economists such as Adam Smith and Karl Marx generally recognize the importance of property rights in the process of economic development, and modern mainstream economics agree with such a recognition[93]. A widely-accepted explanation is that well-enforced property rights provide incentives for individuals to participate in economic activities, such as investment, innovation and trade, which lead to a more efficient market[94].The development of property rights in Europe during the Middle Ages provides an example. During this epoch, full political power came into the hands of hereditary monarchies, which often abused their power to exploit producers, to impose arbitrary taxes, or to refuse to pay their debts. The lack of protection for property rights provided little incentive for landowners and merchants to invest in land, physical or human capital, or technology. After the English Civil War of 1642-1646 and the Glorious Revolution of 1688, shifts of political power away from the monarchs led to the strengthening of property rights of both land and capital owners. Consequently, rapid economic development took place, setting the stage for Industrial Revolution[95].

Property rights are also believed to lower transaction costs by providing an efficient resolution for conflicts over scarce resources.[96] Empirically, using historical data of former European colonies, Acemoglu, Johnson and Robinson find substantial evidence that good economic institutions – those that provide secure property rights and equality of opportunity

[89] (Alchian , 2008)
[90] (Eggertsson, 1990)
[91] (Klein & Robinson, 2011)
[92] (An, 2013, pp. 481-495)
[93] (Besley, et al., 2009)
[94] (Acemoglu, et al., 2005, p. 397)
[95] (Acemoglu, et al., 2005, pp. 385-472)
[96] (Alchian & Demsetz, 1973, pp. 16-27)

– lead to economic prosperity[97]. Harold Demsetz is the economist, who explored the *"long chain of this causation"*. According to his point of view changes in technology or the opening of new markets create changes in economic values which in their turn increase internalization and lead to property rights. Changes may not be conscious but come about through social mores or common law precedents. In this context property rights are the socially constructed instruments that help us form expectations about our dealings with others, expressed as laws, customs, or norms .The *"main allocative function of property rights is the internalization of beneficial and harmful effects" (*externalities). Thus, property rights emerge of the *"emergence of new or different beneficial and harmful effects to internalize externalities when the gains of internalization become larger than the cost of internalization"*. Demsetz used as a typical example the property rights that were established by Indians in Quebec after the beaver fur trade picked up. Thus, they internalized the negative externality of animals' extinction because of overhunting, exactly when the beavers'salvation appeared to them as an urgent need[98].

In my point of view Demsetz's theory about *"the long chain of causation of property right's establishment"* can be perfectly applied in the case of GHG emissions, as well. The property rights in the form of emissions allowances similarly emerged to internalize the negative externality of environmental pollution due to overabusive industrial production process, exactly when the negative effects of the climate change begun to threat our civilized world and the planet's salvation appeared to us as an urgent need. Indeed the lack of an international agreement regarding the urgency to combat climate change by reducing GHG emissions is founded exactly on the disagreement between the scientific community and the industrial interests on the excessivity of externalities'internalization gains (reverse of the negative effects of climate change) when compared with the cost of internalisation (industrial losses).

2. *Carbon credits*

Dales [99]is viewed as the founding father of the tradable emission rights concept. His ideas can be traced back to the property rights school in economics which holds that externalities should be internalized[100], so that negative external costs that are not reflected in the market price, such as environmental pollution, are included in this price by allocating property rights.

Although most economists see tradable emission rights as property rights, a legal provision was adopted in the US that a tradable SO_2'allowance' does not constitute a property right (in section 403(f) of the CAAA). This formulation was chosen to avoid compensation payments to polluters for 'taking' allowances when the government lowers the annual emission caps. Both in the US and in the EU, an emission right is basically defined as an allowance that authorizes a legal entity to emit a certain amount of pollution during a specified period. This is not so much a permanent, private property right, but rather an authorization that can be terminated or limited by the government. Therefore, the law and economics literature prefers to characterize allowances as *mixed, hybrid or regulatory property rights*[101] [102]. Emission rights contain elements of both public and private property rights: allowances are non-permanent, governmentmandated rights that combine state control over the emission quotas with private

[97] (Acemoglu, et al., 2005, pp. 385-472)
[98] (Demsetz, May 1967, pp. 347-359)
[99] (Dales, 1968)
[100] (Demsetz, May 1967)
[101] (Rose, 1999, pp. 45-72)
[102] (Yandle, 1999, pp. 13-44)

freedom for polluters to choose how to comply (sometimes referred to as 'command-without-control'). Moreover, although allowances are not property rights themselves, property rights in allowances are in fact recognized, as emitters can receive, hold and transfer them, while excluding all others, besides the government, from interfering with their possession, use and disposition[103].[104]

A carbon credit is a permit or certificate allowing the holder to emit carbon dioxide or other greenhouse gases. The credit limits the emission to a mass equal to one ton of carbon dioxide (tCO_2e). Carbon credits create a market for reducing greenhouse emissions by giving a monetary value to the cost of polluting the air. Emissions become an internal cost of doing business and are visible on the balance sheet alongside raw materials and other liabilities or assets.There are many companies that sell carbon credits to commercial and individual customers who are interested in lowering their carbon footprint on a voluntary basis. These carbon offsetters purchase the credits from an investment fund or a carbon development company that has aggregated the credits from individual projects. Buyers and sellers can use an exchange platform to trade, which is like a stock exchange for carbon credits[105].

3. *Financialisation of the environment*

The carbon market has grown substantially since its start. As it gets more sophisticated, it is important that the rules governing oversight of the market keep pace with its development and adequately address risks that may arise. In principle, anyone can trade in the carbon market. The main categories of traders are energy companies, industrial companies and financial intermediaries such as banks which also act on behalf of smaller companies and emitters[106].

A significant part of daily transactions in emission allowances is in the form of derivatives (futures, forwards, options, swaps). In fact, an Emission Trading System is a financial market with all the risks it involves (speculation, market abuse, etc.). In order to ensure the reliability of the system, strong market oversight is necessary, especially considering the small size of the current markets. Registry recording ownership of allowances have to be secured against hacking, like any banking system[107]. Furthermore, in order to ensure a safe and efficient trading environment and to enhance confidence in the market, it is very important to prevent market abuse and other market misconduct. More specifically regulation has to be revised so as to secure the application of high integrity standards to all market participants, who would be prohibited from engaging in manipulation through practices such as spreading false information or rumours, the regulated with large installations companies'inability to profit from inside information at the detriment of other market participants, better transparency, all market participants'simpler access to information (e.g. how much is traded and at what price on carbon exchanges) and the extention of Anti-money laundering safeguards (e.g. know-your-customer checks) to all segments of the carbon market[108].

As far as the EU ETS is concerned, Transactions in emission allowances are already subject to EU financial markets regulation. This is being replaced by the new Financial Market Directive

[103] (Cole, 1999, pp. 103-130)
[104] (Woerdman, et al., 1.12.2007)
[105] ("Investment Dictionary")
[106] (EUROPA)
[107] (Union for the Mediterranean, 2016)
[108] (EUROPA)

(MiFID2[109] package) applicable since January 2018. Under this new directive, emission allowances are classified as financial instruments. This means that rules applicable to traditional financial markets (those including carbon derivatives trade on leading platforms or over-the-counter (OTC)) also apply to the spot segment of the secondary carbon market, putting emission allowances on an equal footing with the derivatives market in terms of transparency, investor protection and integrity. Moreover, by virtue of cross-references to MiFID2 definitions of financial instruments, other pieces of financial market legislation apply. This is in particular the case for the Market Abuse Regulation (MAR[110]), which covers transactions and conduct involving emission allowances, on both primary and secondary markets and applies as reviewed since July 2016 to derivative financial instruments relating to emission allowances. Similarly, a cross-reference to MiFID2 in the Anti-Money Laundering Directive[111] triggers a mandatory application of customer due diligence checks by MiFID-licensed carbon traders to their clients in the secondary spot market in emission allowances[112].[113] Further implementing and delegated legislation has also been developed with the European Securities and Markets Authority (ESMA), which has published Technical Advice and draft Implementing and Regulatory Technical Standards under the Market Abuse Regulation, as well as under the Markets in Financial Instruments Directive and Regulation, also addressing specific issues for the EU ETS[114].

As a final point, linking of ETS is also a strong will of OECD countries and market players (especially for offsetting) to have one single global price signal. Price switch differs according to fossil fuel markets. Asymmetric linking between markets is really relevant, in order to prevent market speculation (ex.Aviation sector and other activities under the EU-ETS). Different carbon price could be set for CO2 avoided and CO2 emitted.[115]

[109] Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU

[110] Regulation (EU) No 596/2014 of the European Parliament and of the Council of 16 April 2014 on market abuse (market abuse regulation) and repealing Directive 2003/6/EC of the European Parliament and of the Council and Commission Directives 2003/124/EC, 2003/125/EC and 2004/72/EC

[111] Directive (EU) 2015/849 of the European Parliament and of the Council of 20 May 2015 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing, amending Regulation (EU) No 648/2012 of the European Parliament and of the Council, and repealing Directive 2005/60/EC of the European Parliament and of the Council and Commission Directive 2006/70/EC

[112] Due diligence checks are already mandatory in the primary market and in the secondary market in emission allowances' derivatives.

[113] (EUROPEAN COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL, 23.11.2017)

[114] (EUROPA)

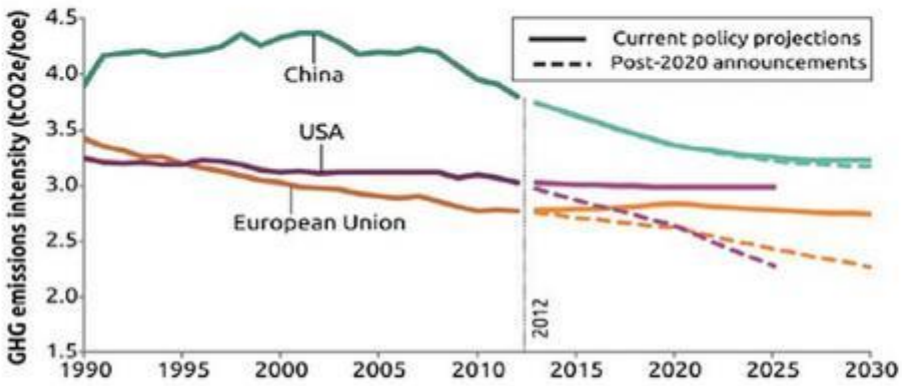
[115] (Union for the Mediterranean, 2016)

IV. Emissions Trading Scheme

1. *Emission Trading all over the world*

An increasing number of countries and regions around the world are developing and implementing emissions trading as a means to place a price on greenhouse gas (GHG) emissions. Given the difficulties of achieving consensus on climate change mitigation measures through the multilateral climate negotiations, momentum appears to have shifted from the international level to that of nation states and regions[116]. A particularly strong dynamic is visible in rapidly developing economies, with new trading systems under discussion. According to the CAT Countries assessment[117], if China, the US and the European Union (who together comprise around 53% of global emissions) implement their post-2020 plans, they would limit global temperature rise to around 3˚C by 2100 - 0.2˚C-0.4˚C lower than it would have been prior to their announcements. These findings represent significant progress and are more ambitious than previous commitments, but remain insufficient to limit warming below 2˚C. However, as it is indicated in the following Figure, China GHG intensity for the post 2020 policies is at the same levels with current policies.

Figure 3: GHG intensity trends for EU, US, China with the post 2020 policies



Source: Climate Action Tracker policy brief (CAT), December 2014, https://climatepolicyinfohub.eu/international-ambition-targets-post-2020-era

To date, 51 carbon pricing initiatives have been implemented or are scheduled for Implementation globally, as shown in Figure 4. This consists of 25 emissions trading systems (ETSs), mostly located in subnational jurisdictions, and 26 carbon taxes primarily implemented on a national level. These carbon pricing initiatives would cover 11 gigatons of carbon dioxide equivalent (GtCO2e) or about 20 percent of global greenhouse gas (GHG) emissions, as shown in Figure 3. In 2018, the total value of ETSs and carbon taxes is US$82 billion, representing a 56 percent increase compared to the 2017 value of US$52 billion. Korea's ETS covers sectors that emit over half a billion tonnes of GHG and the programme in California and Quebec covers sectors emitting nearly half a billion tonnes while the seven Chinese pilot emission trading systems collectively cover sources emitting over one billion tonnes of CO_2. The world's largest carbon market is the European Emissions trading scheme (EU-ETS), covering sectors that emit over 2 billion tonnes of carbon dioxide each year or 45% of the total EU GHG emissions.[118]Howver, according to the World Resources Institute.,

[116] (Tuerk, et al., 2012)
[117] (Climate Action Tracker)
[118] (World Bank Group & Ecofys, 2018, pp. 8-13)

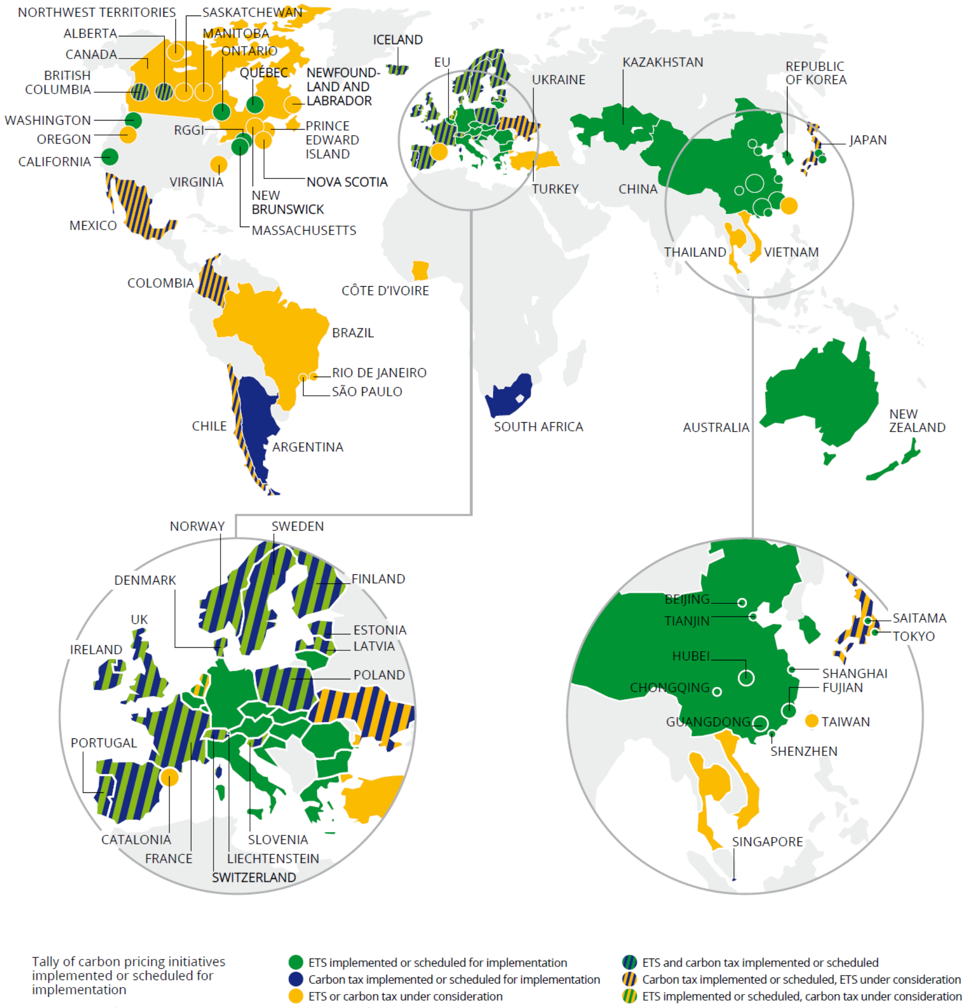
EU-28 covers just the 9.33% of global GHG emissions, while USA cover the 14.75% and China the 25.9%, as the world's biggest GHG emitter.[119]

More specifically, national emission trading programmes have been discussed in the US and Canada, but have so far failed to receive the necessary political support. Instead, North American carbon trading systems have emerged at the regional level: nine US States have joined forces in a joint trading system called the Regional Greenhouse Gas Initiative (RGGI), that entered into force on the 1st January 2009 covering only CO_2 emissions from electricity generation and the Western Climate Initiative (WCI) of Canadian province Quebec linked with California's emissions trading programme in January 2014[120]. Most of the recent developments in carbon pricing initiatives came from the America, with all six newly implemented carbon pricing initiatives in 2017–2018 located in this region (ex. Chile, Colombia, Alberta, Massachusetts etc.)[121].

On the ther hand, Asia has seen a strong dynamic toward emission trading in 2013, with five Chinese cities and two provinces starting pilot carbon markets – together, those regions account for about one-fourth of Chinese GDP and CO_2 emissions. In 2015 all programmes had entered into force. Chinese leaders are also considering a national emission trading scheme. Despite two previous delays, according to experts late 2020 remains the likely launch date for the world's biggest carbon market[122]. The Kazakhstan Emissions Trading Scheme started with a pilot phase in 2013 and was restarted in 2018 following a two-year suspension. Moreover, South Korea's emission trading programme entered into force in January 2015 covering over 60% of the country's emissions. The Tokyo Metropolitan Government has been operating a trading scheme (TMG ETS) for indirect CO_2 emissions since 2010. However, Japan is not planning to implement a national emission trading system. In addition New Zealand's small ETS (NZ ETS) has been operating since 2008 being the only ETS to include forestry as a covered sector while Australia abandoned a long-planned national ETS in 2013 after a change in government. [123]

[119] (World Resources Institute, 2014)
[120] (climatepolicyinfohub.eu, n.d.)
[121] (World Bank Group & Ecofys, 2018, pp. 8-13)
[122] (Carbon Pulse, 12.12.2018)
[123] (climatepolicyinfohub.eu, n.d.)

Figure 4: Summary map of existing, emerging and potential regional, national and subnational carbon pricing instruments worldwide (ETS and carbon tax).



Source: World Bank; Ecofys. 2018. State and Trends of Carbon Pricing 2018. Washington, DC: DC: World Bank, p.9, License: CC BY 3.0 IGO. https://openknowledge.worldbank.org/handle/10986/29687

Although neither the US nor Canada have national emission trading systems, they are home to regional carbon markets. At the same time various ETS are emerging at regional and national level are in Asia. Some of these differ from the 'traditional' schemes in industrialised countries (such as RGGI and the EU ETS), which mainly address emissions from heavy industry and the power sector involving smaller facilities or buildings and including indirect emissions from energy consumption. Moreover, only few ETS worldwide have a significant share of auctioning from the beginning. Similar to the EU-ETS, other ETS pilots allocate most allowances for free. Given the current dynamics in Asia, the future of global emissions trading will depend on developments in Asia and, to a lesser degree, other parts of the developing world. If this dynamic continues, emerging economies could eventually overtake the European Union and other OECD countries as centers for emissions trading, which in turn would significantly shift the style, nature and challenges of a future international carbon market.[124]

[124] (climatepolicyinfohub.eu)

International carbon markets can play a key role in reducing global greenhouse gas emissions cost-effectively.The number of emissions trading systems around the world is increasing. The Korean emissions trading system (KETS), launched in 2015, covers around 66% of Korea's total greenhouse gas emissions. It is the first mandatory emissions trading system among non-Annex I countries under the UNFCCC. The KETS could trigger the expansion of emissions trading among emerging economies and developing countries. The European Commission supports Korea through a technical assistance project focused on building the necessary capacity to implement the KETS. Linking compatible emissions trading systems with each other enables participants in one system to use units from another system for compliance purposes. Linking offers several potential benefits, including reducing the cost of cutting emissions, increasing market liquidity, making the carbon price more stable, levelling the international playing field by harmonising carbon prices across jurisdictions and supporting global cooperation on climate change. The EU ETS legislation provides for the possibility to link the EU ETS with other compatible emissions trading systems in the world at national or regional level. Conditions for linking include system compatibility (the systems have the same basic environmental integrity, and a tonne of CO_2 in one system is a tonne in the other system), the mandatory nature of the system, and the existence of an absolute cap on emissions. The EU and Switzerland have signed an agreement to link their systems. Once the agreement has entered into force, linking would result in the mutual recognition of EU and Swiss emission allowances. Switzerland would keep a separate system from the EU ETS. The EU and Australia also considered the possibility to link their systems. However, due to the repeal of the Australian system in 2014, the linking negotiations have not been pursued.[125]

2. *European Union Emission Trading System (EU ETS)*

The EU Emissions Trading System (EU ETS) is a key pillar, a cornerstone of European climate policy to combat climate change. As a cap-and-trade scheme for carbon dioxide, it contributes to the EU’s greenhouse gas reduction targets by setting a cap on the maximum level of emissions for the sectors covered and establishing an installation-level market for emission permits, which generates a price for them. Allocation is done for free or by auctioning generating revenues for States to invest in low-carbon technologies. Permits can then be traded on the open market. Businesses need to buy enough emissions allowances, so as to cover their emissions. The higher the price, the greater the incentive to cut pollution. In operation since 2005, EU ETS has faced a number of challenges resulting from the creation of the largest market for an environmental commodity in history. Currently, the EU ETS operates in 31 countries and more specifically in all 28 EU Member States as well as in Iceland, Liechtenstein and Norway (three countries belonging to the European Economic Area (EEA-EFTA)) since 2008.

Participation in the EU ETS is mandatory for companies in the following sectors**,** but in some sectors only plants above a certain size are included. Certain small installations can be excluded if governments put in place fiscal or other measures that will cut their emissions by an equivalent amount. The system covers the following sectors and gases with the focus on emissions that can be measured, reported and verified with a high level of accuracy:

- carbon dioxide (CO2) from power and heat generation, energy-intensive industry sectors including oil refineries, steel works and production of iron, aluminium,

[125] (Europa)

metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals and commercial aviation (until 31 December 2023 the EU ETS will apply only to flights between airports located in the EEA)

- nitrous oxide (N2O) from production of nitric, adipic and glyoxylic acids and glyoxal
- perfluorocarbons (PFCs) from aluminium production.[126]

More than 11,000 covered entities account for around 2 gigatonnes or 45% of EU total GHG emissions that come from energy intensive sectors [127]. The EU ETS target is a reduction of 21% of emissions compared to 2005 levels until 2020 and 80-90% until 2050 compared to 1990 levels. The system is intended to assist the EU in reaching both its immediate as well as longer-term emissions reduction objectives by "promoting reductions of emissions in a cost-effective and economically efficient manner"[128].

The EU ETS is the first and largest emissions trading system in the world. It remains the biggest one, accounting for over three-quarters of international carbon trading.[129] It is highly centralized with a single EU registry, a common auctioning platform, a strong legislative backup from the European Commission. It has no administrative burden for States, as covered by the auctioning revenues. Reliable and accurate monitoring, reporting and verification (MRV) of GHG emissions is essential to avoid frauds and ensure market trust, although it can be seen as a burden for installations.[130] The EU ETS is inspiring the development of emissions trading in other countries and regions. The EU aims to link the EU ETS with other compatible systems.[131]However, derogation for small emitters and cost-effectiveness of available IT systems for MRV have to be considered. [132]

3. *Legal basis*

A. *Kyoto Protocol*

The origins of the EU ETS can be traced back to 1992 when 180 countries agreed to avoid dangerous level of human made global warming and signed the United Nations Framework Convention on Climate Change (UNFCCC). As a means of specifying action to be taken as part of this global joint effort, the Kyoto Protocol (KP) was consequently agreed upon in 1997. [133]The 1997 Kyoto Protocol – an agreement under the UNFCCC– was the world's only legally binding treaty between countries to limit or reduce their greenhouse gas emissions. By setting such targets, emission reductions took on economic value. To help countries meet their emission targets, and to encourage the private sector and developing countries to contribute to emission reduction efforts, negotiators of the Protocol included two market-based mechanisms, the clean development mechanism (CDM) and Joint Implementation (JI).[134] However, because many major emitters are not part of Kyoto (The US has indicated its intention not to ratify the Kyoto Protocol and On 15 December 2011,

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[126] (Europa)
[127] (Ms Hedegaard, 2014)
[128] (EUROPEAN PARLIAMENT & EUROPEAN COUNCIL, 2003, pp. 32,Art. 1, Directive EC/87/2003)
[129] (Europa)
[130] (Union for the Mediterranean, 2016)
[131] (Europa)
[132] (Union for the Mediterranean, 2016)
[133] (climatepolicyinfohub.eu)
[134] (United Nations)

the Depositary received written notification of Canada's withdrawal from the Kyoto Protocol. This action became effective for Canada on 15 December 2012), it only covers about 18% of global emissions.[135]

Clean Development Mechanism (CDM) is defined in Article 12 of the Kyoto Protocol and is one of the Protocol's flexible mechanisms. Under the CDM, industrialised countries with emission reduction commitments under the Protocol (called Annex 1 countries) can finance greenhouse gas reduction projects in developing countries as an alternative to more expensive emissions reductions in their own countries, to earn certified emission reduction (CER) credits that count towards meeting the reduction targets under the Protocol.[136]The CDM stimulates sustainable development and emission reductions in developing countries, while giving industrialized developed countries some flexibility in how they meet their emission reduction limitation targets under the Kyoto Protocol through the use of tradable, saleable certified emission reduction (CER) credits that they earn through CDM projects. Benefits of CDM projects include investment in climate change mitigation projects in developing countries, transfer or diffusion of technology in the host countries, as well as improvement in the livelihood of communities, poverty reduction, access to energy efficient lighting and cooking, improvement of air quality and living conditions through the reduction of costs, the creation of employment (generation of jobs and skills) or increased economic activity.The CDM is the main source of income for the UNFCCC Adaptation Fund, which was established in 2001 to finance adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change. The Adaptation Fund is financed by a 2% levy on CERs issued by the CDM.[137]

On the other hand, Joint Implementation (JI) is one of the flexible mechanisms of the Kyoto Protocol (KP), defined in Article 6 of the KP. The mechanism allows industrialised countries with emission reduction or limitation commitments under the KP (called Annex B countries) to earn Emission Reduction Units (ERUs) equivalent to one tonne of CO_2 through emission reduction/removal projects in another industrialised country. The ERUs can be counted towards meeting the country's respective KP target.[138]

The KP introduced two principles essential for the establishment of the EU ETS. Firstly, it contained absolute quantitative emission targets for industrialised countries and secondly it included a set of so-called flexible market-based mechanisms, which allowed for the option to exchange emission units between countries as an International Emissions Trading system.[139]The EU ETS is the first market for CDM globally.[140]

i. Kyoto 1st commitment period (2008–12)

In the first commitment period of the Kyoto Protocol (2008-12), participating countries committed to reduce their GHG emissions by an average of 5% compared to 1990

[135] (Europa)
[136] (climatepolicyinfohub.eu)
[137] (United Nations)
[138] (climatepolicyinfohub.eu)
[139] (climatepolicyinfohub.eu)
[140] (Union for the Mediterranean, 2016)

levels.[141]The targets cover emissions of the six main greenhouse gases, namely Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6). The maximum amount of emissions (measured as the equivalent in carbon dioxide) that a Party may emit over a commitment period in order to comply with its emissions target is known as a Party's Assigned Amount Units (AAUs). [142] The huge surplus of these emission rights for certain countries from the 1st Kyoto period had threatened to undermine incentives to meet emissions targets in the new period. To prevent this, there will be a limit on how much can be carried over from Kyoto period I.[143]

The EU and its member states – 15 in 1997, the time that the legislation was adopted (the 'EU-15') – went beyond the above average target and committed to an 8% cut for the bloc as a whole. As the Protocol allowed groups of countries to meet their targets jointly through a scheme known as a "bubble", whereby countries have different individual targets, but which combined make an overall target for that group of countries, the EU's overall 8% reduction was broken down into legally binding national targets, so as to be redistributed among the member states. These targets were tailored to the relative wealth of each country at the time, under the *"burden sharing"* agreement, included in the Council decision of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the UNFCCC and the joint fulfilment of commitments thereunder approving the Kyoto Protocol (Decision 2002/358/EC[144]). They were expressed as percentages of emissions in a chosen base year and translated into an exact national cap on greenhouse emissions (expressed in tonnes of CO_2-equivalent) for the whole 2008-12 period. Similar individual targets have been set for countries that joined the EU after the Protocol was adopted – except for Cyprus and Malta, which have no targets.[145]

At that point of time 'EU-15' lacked the policy instruments to define a strategy to meet these targets, so as to bring about this reduction. Internal debates on plans to introduce a carbon or energy tax had not proven to be successful. Several countries were moving ahead with national emission reduction policies (such as support for renewable energy), but others were waiting for common and coordinated policies and measures to be introduced EU wide. In this general context, the European Commission (EC) entering a more dynamic phase in climate policy making, started elaborating a proposal for an EU emission trading system to tackle the emissions from key economic sectors (especially energy and industry). [146]In 2000, the European Climate Change Programme (ECCP) was launched which examined an extensive range of policy sectors and instruments with potential for reducing GHG emissions and developed common and coordinated strategies to fulfil the Kyoto targets. [147] As a result, the EU ETS with national caps for emissions from power and industry sectors in each MS was instituted as one of the key policy measures to reach the Kyoto targets.

Finally the 'EU-15' has met its commitments under the Kyoto Protocol's first commitment period (2008-2012). For the whole period, the EU's total emissions were 23.5 gigatonnes of CO_2 equivalent. This is equivalent to a reduction of around 19% below the

[141] (Europa)
[142] (United Nations)
[143] (Europa)
[144] (EUROPEAN COUNCIL, 2002)
[145] (United Nations)
[146] (climatepolicyinfohub.eu)
[147] (climatepolicyinfohub.eu)

base year in the period 2008-2012 achieving an overall cut of 11.7% domestically, without counting the additional reductions coming from carbon sinks (LULUCF) and international credits.[148]

ii. Kyoto 2nd commitment period (2013–20)

This period bridges the gap between the end of the 1st Kyoto period and the start of the new global agreement in 2020. In this period, the EU, some other European countries and Australia have agreed to make further emissions cuts. For their part, the EU countries (together with Iceland) have agreed to meet – jointly – a 20% reduction target compared to 1990 (in line with the EU's own target of 20% by 2020) and they are on track to do so. This joint 20% commitment is shared between these 29 countries and the EU, broadly along the lines of current commitments in each sector of the economy. The EU is responsible for emissions in sectors covered by the emission trading system (ETS) while each country is responsible for its national emissions in the sectors outside the ETS.The measures needed for the EU and its member countries to deliver on the reduction commitment have already been put in place through the 2020 climate & energy package. In Kyoto 2nd period, new rules on how developed countries are to account for emissions from land use & forestry and one more greenhouse gas (making 7 in total) is now covered – nitrogen trifluoride (NF3). Moreover in decision 1/CMP.8, the Parties decided that for the second commitment period, the Adaptation Fund shall be further augmented through a 2 per cent share of the proceeds levied on the first international transfers of AAUs and the issuance of ERUs for Article 6 projects immediately upon the conversion to ERUs of AAUs or RMUs previously held by Parties. EU implementation of Kyoto 2nd period also required the EU to ratify the Doha Amendment to Kyoto (2013). The EU is on track to meet its targets under the second commitment period of the Kyoto Protocol. [149]

iii. International credits

International credits are financial instruments that represent a tonne of CO2 removed or reduced from the atmosphere as a result of an emissions reduction project. At present, international credits are generated through two mechanisms set up under the Kyoto Protocol. These are the Joint implementation (JI), which provides for the creation of emission reduction units (ERUs), and the Clean Development Mechanism (CDM) which provides for the creation of certified emission reductions (CERs).[150]

Participants in the EU ETS can use international credits from CDM and JI towards fulfilling part of their obligations under the EU ETS until 2020, subject to qualitative and quantitative restrictions. EU legislation specifies maximum limits up to which operators under the EU ETS may use eligible international credits for compliance in phase 2 and phase 3. As the world's largest carbon market, the EU ETS is currently the biggest source of demand for international credits, making it the main driver of the international carbon market and the main provider of clean energy investment in developing countries and economies in transition. Participants in the EU ETS used 1.058 billion tonnes of international credits in phase 2 (2008-2012). Unused entitlements have been transferred to phase 3 (2013-2020). Since phase 3, CERs and ERUs are no longer compliance units within the EU ETS and must

[148] (United Nations)
[149] (Europa)
[150] (Europa)

be exchanged for EU allowances up to the operators' individual entitlement limit set in the registry. Credits issued in respect of emission reduction in the first commitment period of the Kyoto Protocol (2008-2012) had to be exchanged with EU allowances by 31 March 2015. The use of new project credits/CERs after 2012 is prohibited, unless the project is registered in one of the least developed countries (LDC). The Paris Agreement established a new market mechanism to replace JI and CDM in total after 2020. The EU has a domestic emissions reduction target and does not currently envisage continuing use of international credits after 2020. [151]

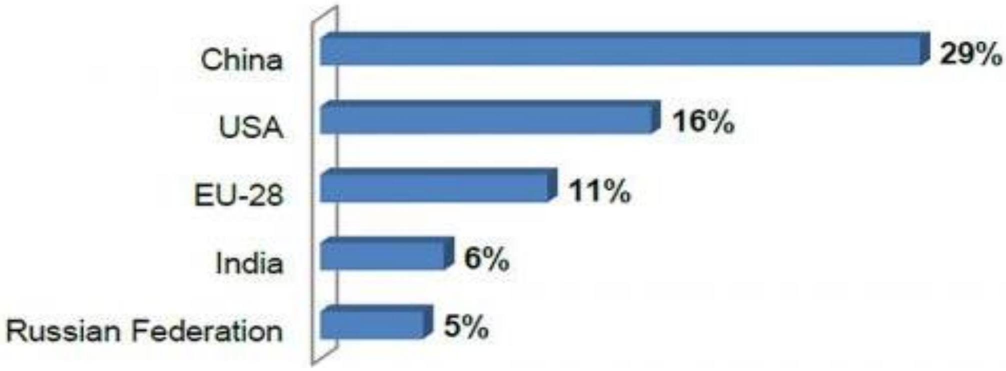
B. The Paris Agreement: the world unites to fight climate change

At the United Nations (UN) Climate Change Conference, held in Durban in 2011, governments agreed that they needed to accelerate the reduction of global GHG emissions and that the existing international regime, the 1992 United Nations Framework Convention on Climate Change (UNFCCC) needed to be strengthened. The UNFCCC itself was a rather vague framework treaty. Parties only later agreed on binding mitigation targets under the 1997 Kyoto Protocol, but only for developed countries and with important actors, like the United States not ratifying the Protocol. Parties thus decided in Durban to launch a negotiation process that would develop a new legal agreement to be adopted in 2015 in Paris and that would be applicable to all Parties[152]. The agreement was set to enter into force in 2020. This new negotiation track, named the *"Ad-hoc Working Group on the Durban Platform for Enhanced Action"* (ADP 2011) is crucial because it also tries to bring on board all Parties, including major emitters of GHG emissions among the developing countries.

At the 19th Conference of Parties (COP 19) in 2013 in Warsaw, Parties agreed that they would initiate or intensify domestic preparation for their so called *"intended nationally determined contributions"* (INDC) towards that agreement, and to communicate these well before the COP21 in Paris in December 2015. These INDCs set out the mitigation pledges, countries are willing to propose for the period post-2020. This decision can be seen as a big step for developing countries, many of which were for the first time designing mitigation plans or targets, or communicating them at the international level. By the end of October, 155 Parties (including the European Union member states on March 6th 2015[153]) have submitted their INDCs. This includes the largest emitters of CO_2, namely China (29% of global emissions), the United States (16%), the EU (11%), India (6%), the Russian Federation (5%) and Japan (3.8%), accounting for over two thirds of global emissions[154] . Comparing the available data we can assume that five countries constitute over two thirds of global emissions. As it is shown in the following Figure 5 China ranks as top global CO2 emitter, outperforming USA[155].

[151] (Europa)
[152] (UNFCCC, 2011)
[153] (UNFCCC, 2015)
[154] (European Commission, 2014)
[155] (climatepolicyinfohub.eu)

Figure 5: Emissions of top CO2 emitters, as percentage of total global emissions



Source: European Commission, A policy framework for climate and energy in the period from 2020 to 2030, 2014, available at: https://climatepolicyinfohub.eu/international-ambition-targets-post-2020-era #footnote227y07wwz

At the Paris climate conference (COP21) on 12 December 2015 under the UNFCCC, 195 countries adopted the first-ever universal, legally binding global climate deal. The Paris Agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming. It is a bridge between today's policies and climate-neutrality before the end of the century. The agreement opened for signature for one year on 22 April 2016. To enter into force, at least 55 countries representing at least 55% of global emissions had to deposit their instruments of ratification. On 5 October, the EU formally ratified the Paris Agreement, thus enabling its entry into force on 4 November 2016.

More specifically, its Parties' governments agreed a long-term goal of holding the increase in the global average temperature to well below 2°C above pre-industrial levels. Their aim to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels was focused to the significant reduction of risks and impacts of climate change. Respectful to their agreement on the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries, rapid reductions were undertaken in accordance with the best available science. Before and during the Paris conference, countries submitted comprehensive national climate action plans (INDCs). These are not yet enough to keep global warming below 2°C, but the agreement traces the way to achieving this target. The Paris Agreement also recognises the importance of averting, minimising and addressing loss and damage associated with the adverse effects of climate change while acknowledges the need to cooperate and enhance the understanding, action and support in different areas such as early warning systems, emergency preparedness and risk insurance. The role of non-Party stakeholders in addressing climate change, including cities, other subnational authorities, civil society, the private sector and others is also highlighted through their invitation to scale up their efforts and support actions to reduce emissions, to build resilience and decrease vulnerability to the adverse effects of climate change upholding and promoting regional and international cooperation.The Parties have also agreed to periodically take stock of the implementation of the Paris Agreement and to assess the collective progress towards achieving the its purpose and its long-term goals coming together every 5 years to set more ambitious global targets as required by science, reporting to each other and the public on how well they are doing to implement their targets and tracking progress towards the long-term goal through a robust transparency and accountability system.

Developed countries are supposed to be adapted by strengthening societies' ability to build resilience to deal with the impacts of climate change and providing continued and enhanced international support for adaptation to developing countries. They are intended to continue their existing collective goal to mobilise USD 100 billion per year by 2020 and extend this until 2025. A new and higher goal will be set for after this period. Especially the EU has been at the forefront of international efforts towards a global climate deal to fight climate change. Following limited participation in the Kyoto Protocol and the lack of agreement in Copenhagen in 2009, the EU has been building a broad coalition of developed and developing countries in favour of high ambition that shaped the successful outcome of the Paris conference. The EU was the first major economy to submit its intended contribution to the new agreement in March 2015. On 5 October, formally ratified the Paris Agreement, thus enabling its entry into force on 4 November 2016.The EU was the first major economy to submit its intended contribution to the new agreement in March 2015.The EU's nationally determined contribution (NDC) under the Paris Agreement is to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990, under its wider 2030 climate and energy framework. All key legislation for implementing this target has been adopted by the end of 2018. Other countries are encouraged to provide or continue to provide such support voluntarily.

As far as international carbon markets are concerned, the Paris Agreement taking into consideration the increasing number of emissions trading systems around the world provides for a robust and ambitious basis for their use and reinforces international targets, transparency and the accountability of Parties. Recognising their key role, Article 6 of the agreement allows Parties to use international trading of emission allowances to help achieve GHG emissions reduction targets in a cost-effective way. More specifically it establishes a clear and robust framework requiring parties to apply accounting rules to approaches that involve use of *"internationally transferred mitigation outcomes"* towards nationally determined contributions.These rules will enable linking of carbon markets in the future while ensuring the integrity of commitments. Finally, it provides for a mitigation market mechanism to replace existing mechanisms (such as CDM and JI) and certification of emission reductions for use towards nationally determined commitments. This could facilitate participation in international carbon markets on the basis of a defined contribution to mitigation.[156]

C. Overview of Climate Targets in Europe

Since the 1990s the EU has been pursuing climate change mitigation targets. Following the international commitment to the legally binding GHGs reduction under the Kyoto Protocol, the approach was broadened and deepened with the EU targets for 2020, 2030 and 2050. The Kyoto targets are different from the EU's own 2020 targets. To be capable of distinguishing between Kyoto and EU targets, we shall take into consideration the fact that the first ones cover different sectors –for instance, land use, land use change & forestry (LULUCF) but not international aviation– and that they measure against different years (base years) and not always 1990. Moreover, they require the EU to keep its emissions at an average of 20% below base-year levels over the whole second period (2013-2020) and not only by 2020. An EU-wide climate policy framework has been developed, implemented, and revised over time.[157]

The development of EU climate policy is closely related to the international negotiations organised under the United Nations (UN). It was in 1990, against the backdrop of the first

[156] (Europa)
[157] (Europa)

summary report of the Intergovernmental Panel on Climate Change (IPCC) and in preparation of the upcoming negotiations on the UNFCCC, that climate change was discussed by the European Council for the first time. In the same year, EU leaders agreed to implement the first European climate target, namely to stabilise GHG emissions of the European Community at 1990 levels by 2000[158]. This target was mainly intended as a signal to the international community about the ambitions of Europe, as EU decision-makers did not determine at that time how the target should be reached or who would do what among its Member States (MS)[159]. As a result, a discussion about common and coordinated policies and measures (PAMs) was triggered. To tackle GHG emissions a proposal on a European CO_2 and energy tax was discussed in 1992. However, there was disagreement in the Community on the need for and content of a CO_2/energy tax and a group of Member States (MS) led by the United Kingdom prevented an introduction.[160]Despite the setback regarding CO_2 taxation, softer instruments in the fields of energy efficiency[161] and renewable energies[162] were agreed on. Nevertheless, there were no quantified targets incurred and the policy implementation could be designed by the MS. With the help of a monitoring mechanism established with Decision 93/389/EEC[163], the Community could assess the development of national policy programmes on the reduction of GHG (there were no MS targets) and monitor progress on the 2000 target.

While the Community tried to promote a joint commitment by the industrialised countries to include this target in the UNFCCC, they were faced with opposition from many countries of the Organisation for Economic Co-operation and Development (OECD), mainly from the USA.[164] In 1992, the UNFCCC was adopted and signed with the aim to provide a framework to stabilize “greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”[165], but without specific targets or measures. The negotiations on a legal instrument under the UNFCCC started at the first Conference of Parties (COP) in Berlin in 1995. In 1996 the European Community first established its own long-term goal to keep global temperature rise below 2°C compared to pre-industrial levels[166].

In preparation for the upcoming summit in Kyoto (COP-3) and to foster international commitments to climate change by leading through example, a specific GHG emissions reduction target of 15% in 2010 (compared to 1990 levels) was agreed upon by EU Ministers in early 1997, which the EU would divide internally in a so-called “burden sharing” agreement to introduce specific national targets for all 15 MS (also known as the “EU bubble”). However, a first attempt at compiling a burden sharing agreement by summing up national efforts only came to 9.2%; the further reductions were planned to be realised after an international agreement would come into place[167]. Although emissions were declining in

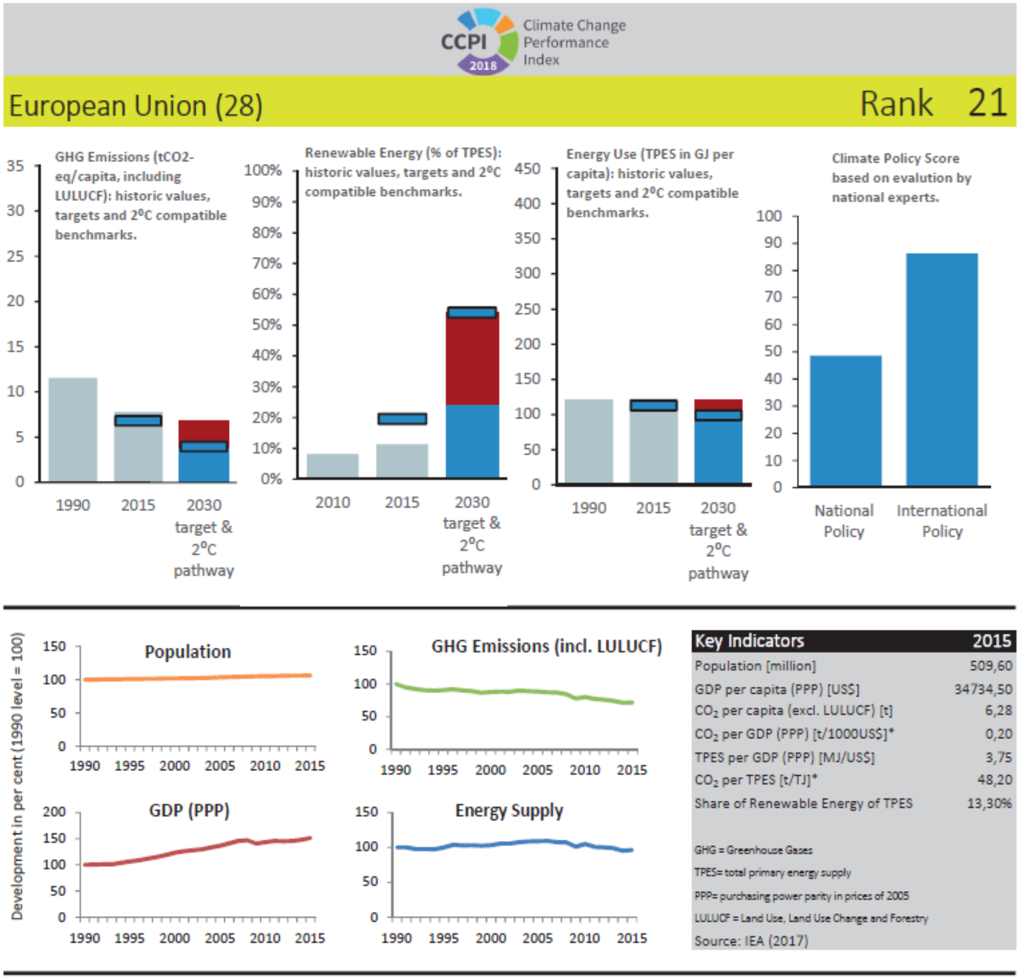
[158] (European Council, 1990)
[159] (Oberthür & Pallemaerts, 2010)
[160] (Oberthür & Pallemaerts, 2010, p. 31)
[161] 91/565/EEC: Council Decision of 29 October 1991 concerning the promotion of energy efficiency in the Community (SAVE programme). OJ L 307, 8.11.1991
[162] 93/500/EEC: Council Decision of 13 September 1993 concerning the promotion of renewable energy sources in the Community (Altener programme). OJ L 235 , 18/09/1993
[163] 93/389/EEC: Council Decision of 24 June 1993 for a monitoring mechanism of Community CO2 and other greenhouse gas emissions. OJ L 167
[164] (Oberthür & Pallemaerts, 2010, pp. 28-30)
[165] (United Nations , 9.05.1992)
[166] (Council of the European Union (Environment))
[167] (Oberthür & Pallemaerts, 2010, p. 34)

the beginning of the 1990s, this was mainly due to effects resulting from the German reunification and the dash for gas in the UK instead of effective climate policies.[168]

As we can assume from the indicators in Figure 6, driven by a comparably high performance in the index' emissions category, 'the European Union (EU) of twenty-eight (28) nations, the only supranational entity in the Climate Change Performance Index (CCPI), lands at place 21 in the ranking. As the union consists of 28 nations, there are wide differences in the performance of individual member states. The EU as a whole accounts for about 8% of global GHG emissions. The EU Emissions Trading Scheme is the largest carbon market in operation but carbon prices are significantly insufficient. EU experts emphasize the union's constructive role in international climate diplomacy but criticize the slow progress in putting in place new and more ambitious policies and targets. Disagreements about the future of the European project would lead to weak agreements based on lowest common denominators, with the failure to substantially reform the Emissions Trading System being the most symptomatic example. They see current discussions on new clean energy policies and how to ensure the EU budget supports such policies as ideal opportunities to increase the ambition of climate action.[169]

[168] (climatepolicyinfohub.eu)
[169] (European Union, 2018)

Figure 6: Indicators of the Climate Changr Performance Index: eu-28 Rank 21



Indicators	Weighting	Score	Rank
GHG per Capita - current level (including LULUCF)	10%	63,75	33
GHG per Capita - current trend (excluding LULUCF)	10%	58,58	21
GHG per Capita - compared to a well-below-two-degrees benchmark	10%	58,35	33
GHG 2030 Target - compared to a well-below-two-degrees benchmark	10%	52,24	35
Share of Renewable Energy in Energy Use (TPES) - current level (including hydro)	5%	26,46	21
Renewable Energy - current trend (excl. hydro)	5%	33,19	25
Renewable Energy Development (excluding hydro) - compared to a well-below-two-degrees benchmark	5%	35,97	14
Renewable Energy 2030 Target (incuding hydro) - compared to a well-below-two-degrees benchmark	5%	57,99	18
Energy Use (TPES) per Capita - current level	5%	62,81	38
Energy Use (TPES) per capita - current trend	5%	57,68	21
Energy Use (TPES) per Capita - compared to a well-below-two-degrees benchmark	5%	68,15	30
Energy Use 2030 Target - compared to a well below two-degrees-benchmark	5%	60,40	40
National Policy	10%	48,50	20
International Policy	10%	86,15	8

Source: ‚European Union 28, 2018, Climate Change Performance Index, Germanwatch 2017, available at: https://www.climate-change-performance-index.org/country/european-union-28

According to Nordaus's conclusion *"the ambitious policy measures, as the ones proposed in the Stern regime*[170]*, are inefficient because they impose too-large emissions reductions in the short run not taking into account that an efficient emissions-control policy has an upward-sloping ramp. Because the initial emissions reductions are so sharp in the ambitious proposals, they impose much higher costs to attain the same environmental objective"*.[171]

[170] (Stern, 2007)
[171] (Nordhaus, 2008)

i. EU Targets 2020

In March 2007, as a means of helping to stimulate the UN negotiations on targets for the period after 2012 (second Kyoto commitment period), EU Heads of States agreed on a set of three targets referred to as "20-20-20"[172] targets of the 2020 EU strategy for smart, sustainable and inclusive growth. It includes:

1. A reduction of greenhouse gas emissions by at least 20% in comparison to 1990 levels,
2. An increase in the share of renewable energies as a percentage of final energy consumption to 20% (as well as a 10% target for renewable fuels) and
3. A 20% improvement in energy savings on the projected EU final energy consumption by 2020 to the level of 1483 Million Tonnes of Oil Equivalent (Mtoe) in terms of primary energy consumption[173], thus achieving approximately a 1.5% energy saving per year up to 2020' (progress in energy efficiency).

These targets are interrelated and mutually support one another. EU governments have set national targets in order to check their progress towards each goal and define them in their National Reform Programmes (NRPs) outlining the actions and measures they plan to undertake to meet them. The European Commission (EC) assesses each NRP and provides countryspecific recommendations.[174]

To implement the new targets, the European Commission introduced the Climate and Energy Package in 2009. This package includes four main parts. In addition to the Renewable Energy Directive (RED)[175] laying down national targets for use in electricity, heating/cooling and transport and a Directive on carbon capture and storage (CCS Directive)[176], it consists of a reviewed Directive on emissions trading (ETS Directive)[177] with a single EU-wide cap for ETS sectors for the 3rd allocation period (2013-20) and a Effort-Sharing Decision (ESD)[178] introducing national reduction targets for non-ETS sectors of all Member States.

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[172] (European Council, March 2007)

[173] Primary Energy Consumption" is meant the Gross Inland Consumption excluding all non-energy use of energy carriers (e.g. natural gas used not for combustion but for producing chemicals). This quantity is relevant for measuring the true energy consumption and for comparing it to the Europe 2020 targets. The "Percentage of savings" is calculated using these values of 2005 and its forecast for 2020 targets in Directive 2012/27/EU; the Europe 2020 target is reached when this value reaches the level of 20%., Source: https://ec.europa.eu/energy/sites/ener/files/documents/countrydatasheets_feb2018.xlsx

[174] (Europa)

[175] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, p. 16.

[176] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006, OJ L 140, 5.6.2009, p.114.

[177] Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 Amending Directive 2003/87/EC so as to Improve and Extend the Greenhouse Gas Emission Allowance Trading Scheme of the Community, OJ L140, 5.6.2009, p. 63.

[178] Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the Effort of Member States to reduce their Greenhouse Gas Emissions to Meet the Community's Greenhouse Gas Emission Reduction Commitments up to 2020, OJ L140, 5.6.2009, p. 136.

The Fuel Quality Directive[179] and CO_2 emission performance standards for cars[180] were adopted together with the Climate and Energy Package. Energy efficiency was not directly included in the package through specific measures, but is tackled by a great number of sector specific approaches, including taxation measures, standards and information tools. Since 2012 the Energy Efficiency Directive (EED)[181] is in place as a common framework of measures for the promotion of energy efficiency.

The EU emissions trading system is the EU's key tool for cutting greenhouse gas emissions from large-scale facilities in the power and industry sectors, as well as the aviation sector. It sets a single EU-wide cap, which shrinking each year allows economic actors to trade emission allowances among member states. The ETS covers around 45% of the EU's greenhouse gas emissions. In 2020, the emissions from these sectors should be 21% lower compared to 2005 levels. National emission reduction targets cover the sectors not included in the ETS, such as households, buildings, agriculture, waste, transport (excluding aviation), services and smaller industrial installations, accounting for the 55% of total EU emissions. EU countries have taken on binding annual targets until 2020 for cutting emissions in these sectors (compared to 2005), under the Effort-sharing decision. These national targets differ according to relative national wealth (measured by Gross Domestic Product per capita) from a 20% cut for the richest countries to a maximum 20% increase for the least wealthy. Less wealthy economies are allowed to increase their emissions to accommodate higher economic growth, given that their higher growth rates are likely to go together with emission increases. Progress is monitored by the Commission every year, with each country required to report its emissions.[182]Target fulfilment is to a certain amount linked to Kyoto offset mechanisms (CDM and JI). The Effort Sharing Decision replaces the Burden Sharing Agreement and lays down specific national reduction targets in the non-ETS sectors only. It includes the possibility to transfer parts of assigned allocations to subsequent years and to other EU MS. Furthermore it is possible to realise emission reductions by submitting credits from UNFCCC regulated offset projects (under CDM and JI) up to a limit of 3% of non-ETS GHG emissions in 2005 – every year.[183]

Together the ETS Directive and the ESD regulate the reduction of all GHG emissions of the EU by 20% compared to 1990 levels (i.e. 14% to 2005 levels; 2005 is used as reference year as it is the first year where a split of ETS and non-ETS emissions data was available). The ETS is supposed to contribute 21% reductions in comparison to 2005 levels while the other sectors 10% reductions in comparison to 2005[184]. Due to the division of the GHG target into an EU-wide target for ETS-sectors and country specific targets for non-ETS sectors it

[179] Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC, OJ L 140, 5.6.2009, p. 88.

[180] Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles, OJ L140, 5.6.2009, p. 1.

[181] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on Energy Efficiency, Amending Directives 2009/125/EC and 2010/30/EU and Repealing Directives 2004/8/EC and 2006/32/EC, OJ L 315, 14.11.2012, p. 1.

[182] (Europa)

[183] (climatepolicyinfohub.eu)

[184] (Oberthür & Pallemaerts, 2010)

becomes hard for MS to control their overall national emissions, as emissions in the ETS sector are difficult to influence directly. It also makes it impractical to compare the national 2020 targets to those for 2008-2012. As it appears in Table 1, which gives an overview of the policies implemented before Kyoto, after Kyoto in the late 1990s and early 2000s for the first commitment period, as well as from 2007 to 2010 in preparation for the 2020 targets, policy instruments developed over time. European climate policies have been targeted at the main pillars of climate policy, namely GHG, renewable energies and energy efficiency measures since the beginning. Although with the disagreement on the CO_2 tax there was no coordinated measure tackling GHG emissions in the early 1990s, the following time periods brought about various instruments in this area. Some measures evolved and built on experience with previous measures, which were reshaped or developed further, as a result of policy learning. Also the requirements of certain interest groups actively shaped and influenced the design of climate policies. Regarding GHG for example the EU ETS developed from a system with national caps for each MS towards an EU-wide cap and thereby took some control of MS over certain economic sectors out of MS' hands.[185]

Table 1: The overview of key EU climate policy instruments developed by policy objective

	Pre-Kyoto (1990–1997) aimed at 2000	European Climate Change Programme and additional legislation (1998–2006) aimed at 2010 (or 2008–12)	Climate and Energy Package and additional legislation (2007–2010) aimed at 2020
GHGs	No European policy (discussion on CO_2 tax, which was not adopted) → Mainly national policies	EU ETS (2003)	EU ETS review (2008, 2009) (One EU-wide ETS target / including aviation)
			Effort Sharing Decision (National non-ETS targets)
		Fluorinated Gases Regulation	Fluorinated Gases Regulation review
		Mobile Air-Conditioning Systems Directive	Further implementation
		Voluntary agreement with car manufacturers (1998/1999)	Mandatory standards for cars and vans
RES	ALTENER	Renewable Electricity Directive (2001) Biofuels Directive	Renewable Energy Directive (RED) & Fuel Quality Directive
EEff	SAVE	Energy Services Directive	Energy Efficiency Directive (EED)
		Combined Heat and Power Directive	
		Ecodesign of Energy Using Products Directive	Further implementation
		Energy Labeling Framework Directive	Energy Labeling Framework Directive review
		Energy Performance of Buildings Directive	Energy Performance of Buildings Directive review

Source: European Climate Policy - History and State of Play, https://climatepolicyinfohub.eu/european-climate-policy-history-and-state-play, original source © Ecologic Institute 2015.

As it appears in Table 2, by 2015 the EU as a whole had cut man-made GHG emissions by 22.1 % compared with their 1990 levels. More specifically, between 1990 and 1994 a large drop of 6.8 % occurred, mostly due to structural changes such as a shift from heavy manufacturing industries to more service-based economies, modernization in industries and a change from coal to gas. By far the sharpest single-year decline in GHG emissions since the early 1990s occurred between 2008 and 2009 (– 7.2 %), when the

185 (climatepolicyinfohub.eu)

economic crisis reduced industrial production, transport volumes and energy demand. The decline observed between 2009 and 2012 in Europe as a whole can mainly be attributed to three factors: improvement in the energy intensity of the EU economy, development of RES and the economic slowdown. However, due to the immigration of populations to central Europe per capita emissions were lowest in some eastern and southern European countries whereas Luxembourg emitted the most GHG per capita in the EU. From 2013 to 2014, GHG emissions fell by 3.1 %, while GDP grew 1.7 % but in 2015 transport emissions have risen by 0.5 % for the second consecutive year coinciding with a return of stronger economic growth (2.2%) and colder temperatures. The overall positive trend for non-ETS emissions in the EU can be linked mainly to the building sector as a result of energy efficiency improvements and a less carbon-intensive fuel mix for space heating but mild winter temperatures are also partly responsible for the fall in energy demand. Especially energy industries but also the other sectors, except fuel combustion in transport and international aviation, contributed to these reductions. Consequently, EU is expected to exceed its target by 2020. However, projections show that further efforts will be necessary to put it on track to meeting the 2030 target.

Table 2: Greenhouse gas emissions (index 1990=100)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	100	98.26	95.28	93.6	93.15	94.18	96.16	94.47	93.79	92.04	92.27	93.25	92.42	93.96

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
94.09	93.56	93.44	92.68	90.64	83.98	85.83	83.13	82	80.36	77.41	77.99	77.64	80

Source: European environment agency (EEA), 17Aug 2018, available at:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_30

As more renewable energy means fewer GHG emissions, it can generate economic activity creating added value and employment in Europe while improving the quality of the environment and the standards of living and supporting the diversification of energy sources. EU member countries have also taken on binding national targets for raising the share of renewables in their energy consumption by 2020, under the Renewable Energy Directive. The EU's renewable energy share is relatively high as compared with most emerging and industrialised countries. The EU as a whole is currently on track to meet its 2020 target. As it appears in Table 3 in 2015 it almost doubled providing 16.7 % of gross final energy consumption i.e. the energy supplied to the final consumers for all energy uses including losses, up from 8.5 % in 2004. The extensive use of renewable energy and, by implication, the degree to which renewable fuels were substituted for fossil and/or nuclear fuels contributed to the decarbonisation of the EU economy.The EU supports the development of low carbon technologies through the NER300 programme for renewable energy technologies and carbon capture & storage and Horizon 2020 funding for research & innovation.

Table 3: Share of renewable energy in gross final energy consumption

%	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
EU 28	8.5	9.0	9.5	10.5	11.1	12.4	12.9	13.2	14.4	15.2	16.1	16.7	17.0	20

Source: Eurostat, 17Aug 2018, available at:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_31

The Energy Efficiency Directive or EED (2012/27/EU) creates a framework for enhancing the cost-effective improvement of energy efficiency in the Member States by setting indicative national targets and ensures the EU target is met through the removal of market barriers and imperfections that impede the efficient use of energy. It is complemented by sector-specific instruments such as the Energy Performance of Buildings Directive (2002/91/EC), which sets insulation standards for newly built buildings. The EU has made substantial progress towards its energy efficiency objective. The 2020 target for final energy consumption has already been achieved, as between 2008 and 2015 it fell from 1180 to 1086 Mtoe ('Table 4'). With respect to primary energy consumption ('Table 4'), as the EU in 2015 consumed 10.7 % less than in 2005, between 2015 and 2020 it must achieve a further reduction of just 3.1 % to achieve its target. However, much of the decrease can be attributed to lower economic output (2008-2009) and warmer winters (2013-2014) rather than to a structural shift in energy consumption patterns. Between 2005 and 2015 energy consumption in the services and transport sectors has risen by 35.2 % and 26.3 %, respectively reflecting structural changes in the EU economy, particularly a shift away from an energy-intensive industry to a service-based economy. Concrete efforts need to be made to achieve the 2020 EU target and ensure primary energy consumption returns to a downward path after a slight rebound in 2015-2016, even if economic growth accelerates. Substantial potential for cost-efficient improvements in energy efficiency by the development of new technologies remains untapped. There is particular scope for savings in transport, energy performance of buildings, production processes, awareness-raising amongst consumers and along the energy supply chain.

Table 4: Energy efficiency

Primary energy consumption (index 2005=100)

MTOE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	1,570.0	1,572.9	1,538.7	1,546.9	1,531.3	1,567.2	1,627.3	1,608.7	1,620.1	1,609.0	1,617.6	1,658.0	1,654.8	1,691.8
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
	1,707.5	1,713.3	1,722.5	1,694.0	1,693.0	1,598.9	1,657.5	1,595.4	1,586.1	1,571.2	1,508.6	1,531.9	1,542.7	1,483

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	91.6	91.8	89.8	90.3	89.4	91.5	95.0	93.9	94.6	93.9	94.4	96.8	96.6	98.7
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
	99.7	100.0	100.5	98.9	98.8	93.3	96.7	93.1	92.6	91.7	88.1	89.4	90.0	

Final Energy Consumption

MTOE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	1084,6	1091,1	1065,9	1069,8	1064,0	1082,6	1130,7	1119,2	1127,5	1127,6	1132,7	1156,5	1145,0	1176,6
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
	1188,6	1192,7	1194,4	1173,6	1179,5	1115,8	1163,2	1109,2	1108,5	1108,2	1063,1	1086,2	1107,7	

Source: Aug 20, 2018 - 8, Energy Country datasheets: EU28 countries, EUROSTAT electricity and gas markets survey (update May 2018), European Commission, https://ec.europa.eu/energy/sites/ener/files/documents/countrydatasheets_august2018.xlsx

To sum-up, according to the 2017 Climate Action Progress Report, despite the fact that in 2015, the EU was responsible for 10% of world greenhouse gas emissions, as one of the major economies with the lowest per capita emissions, it is on track to meet the 20% target for 2020 excluding emissions from the land sector but including emissions from international aviation.Taking into consideration the latest figures EU emissions were reduced by 23% between 1990 and 2016, while the economy grew by 53% over the same period. Especially for the year 2016 EU emissions decreased by 0.7%, while GDP grew by 1.9%. Furthermore, the EU continues to be actively involved in international climate policy and increased its climate finance contributions to reach €20.2 billion in 2016. Robust policies at EU and country level and the uptake of low-carbon technologies have contributed to the cuts achieved. Evaluations confirm that innovation, including progress on renewable energy and energy efficiency, has been the main driver behind the emission reductions in recent years, while the shift between economic sectors has had a marginal effect.[186] Achieving the goals of the 2020 package should help increase the EU's energy security – reducing dependence on imported

[186] (European Commission, 2017)

energy and contributing to achieving a European Energy Union and create jobs, advance green growth and make Europe more competitive.

ii. EU Targets 2030

The *2030 climate and energy framework*[187] sets the following key targets at EU level for the year 2030:

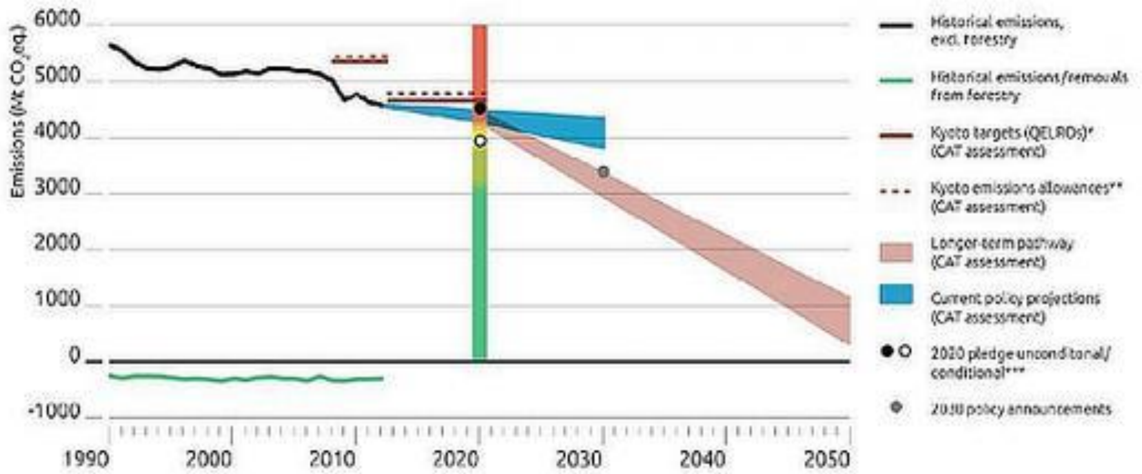
1. a binding EU target of at least 40% domestic reduction of GHG emissions by 2030, compared to 1990;
2. a binding target of at least 27% of renewable energy used at EU level;
3. an indicative and non-binding target of at least 27% increase of energy efficiency. This target will be further reviewed in 2020, having in mind a level of 30% for 2030;
4. the completion of the internal energy market by reaching an electricity interconnection target of 15% between Members States and pushing forward important infrastructure projects.

The framework was adopted by EU leaders in October 2014. It builds on the 2020 climate and energy package. It is also in line with the longer term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper. The binding target to cut emissions in EU territory by at least 40% below 1990 levels by 2030 will enable the EU to take cost-effective steps towards its long-term objective of cutting emissions by 80-95% by 2050 in the context of necessary reductions by developed countries as a group and make a fair and ambitious contribution to the Paris Agreement (EU's INDC submitted to the UNFCCC Secretariat on March 6th 2015[188]).

According to the CAT assessment, the projections with EU's current policies continue the past downward trend and put it on a good trajectory toward meeting its 2020 target. However, while emissions continue to decrease, current policies are projected to reduce emissions by 23-35% below 1990 levels by 2030 and therefore, do not - yet - put the EU on a trajectory towards meeting its 2030 targets (40% reduction, see Figure 7). EU's INDC has also been rated as *"medium"*, due to the fact that the overall level of GHG emissions reductions proposed in it is not yet sufficient to fall within the range of approaches for fair and equitable emission reductions for the EU28[189].

[187] (European Commission, 2014)
[188] (UNFCCC, 2015)
[189] (Climate Action Tracker (CAT) , 2015)

Figure 7: Emissions trajectories for the EU-28 Downward trend in the EU emissions |EU is on a good trajectory toward meeting its 2020 target, but not its 2030 target.



Source: Climate Action Tracker policy brief (CAT), December 2014, available at: https://climatepolicyinfohub.eu/international-ambition-targets-post-2020-era

The EU is putting in place binding legislation to reduce greenhouse_gas_emissions by at least 40% by 2030 compared to 1990 levels, as a part of the EU's 2030 climate and energy framework and contribution to the Paris Agreement. To increase the pace of emissions cuts, the overall number of emission allowances will decline at an annual rate of 2.2% from 2021 onwards, compared to 1.74% currently.[190] The framework includes four main pillars: the revised ETS directive for phase 4 (2021-2030), the Effort Sharing regulation the land use, land use change and forestry (LULUCF) Regulation and the legislation on renewable energy, energy efficiency and governance of the Energy Union. To achieve the at least 40% target EU emissions trading system (ETS) sectors would have to cut emissions by 43% (compared to 2005) -to this end, the ETS is to be reformed and strengthened- and non-ETS sectors would need to cut emissions by 30% (compared to 2005). The Effort Sharing Regulation translates this commitment into binding annual greenhouse gas emission targets for each Member State for the period 2021–2030, based on the principles of *fairness, cost-effectiveness and environmental integrity*. The Regulation adopted on 14 May 2018 continues to recognize the different capacities of Member States to take action by differentiating targets according to gross domestic product (GDP) per capita across Member States. This ensures fairness because higher income Member States take on more ambitious targets than lower income Member States. However, an approach for higher income Member States based solely on relative GDP per capita would mean that some would have relatively high costs for reaching their targets. To address this, the targets are adjusted to reflect cost-effectiveness for those Member States with an above average GDP per capita.The resulting 2030 targets range from 0% to -40% compared to 2005 levels.

The Regulation maintains existing flexibilities under the current Effort Sharing Decision (e.g. banking, borrowing and buying and selling between Member States). In years where emissions are lower than their annual emission allocations, Member States can bank surpluses and use them in later years. For high cumulative surpluses, banking limits have been added. In years where emissions are higher than the annual limit, Member States can borrow a limited amount of allocations from the following year. This gives Member States the flexibility to deal with annual fluctuations in emissions due to weather or economic

[190] (European Council, 2014)

conditions. Member States can also buy and sell allocations from and to other Member States. This is an important vehicle to ensure cost-effectiveness. It allows Member States to access emissions reductions where they are the cheapest, and the revenue can be used to invest in modernisation.

The regulation also provides two new flexibilities to ensure a fair and cost-efficient achievement of the targets. This allows eligible Member States to achieve their national targets by covering some emissions with EU ETS allowances which would normally have been auctioned. EU-wide, this cannot be more than 100 million tonnes CO_2 over the period 2021-2030. Eligible Member States have to notify the Commission before 2020 of the amount of this flexibility they will use over the period. They can revise the amount twice downwards. The flexibility is strictly limited in volume and not taken into account for calculating the feed-in into the ETS market stability reserve. Environmental integrity is maintained and the impact on the carbon market is very limited. To stimulate additional action in the land use sector, Member States can use up to 280 million credits over the entire period 2021-2030 to comply with their national targets. All Member States are eligible to make use of this flexibility if needed for achieving their target, while access is higher for Member States with a larger share of emissions from agriculture. This recognises that there is a lower mitigation potential for emissions from the agriculture sector.

The Market Stability Reserve (MSR) - the mechanism established by the EU to reduce the surplus of emission allowances in the carbon market and to improve the EU ETS's resilience to future shocks – will be substantially reinforced. Between 2019 and 2023, the amount of allowances put in the reserve will double to 24% of the allowances in circulation. The regular feeding rate of 12% will be restored as of 2024. As a long-term measure to improve the functioning of the EU ETS, and unless otherwise decided in the first review of the MSR in 2021, from 2023 onwards the number of allowances held in the reserve will be limited to the auction volume of the previous year. Holdings above that amount will lose their validity.

The revised EU ETS Directive (Directive (EU) 2018/410) entered into force on 8 April 2018. It also provides predictable, robust and fair rules to address the risk of **carbon leakage**. The system of free allocation will be prolonged for another decade and has been revised to focus on sectors at the highest risk of relocating their production outside of the EU. These sectors will receive 100% of their allocation for free. For less exposed sectors, free allocation is foreseen to be phased out after 2026 from a maximum of 30% to 0 at the end of phase 4 (2030). A considerable number of free allowances will be set aside for new and growing installations. This number consists of allowances that were not allocated from the total amount available for free allocation by the end of phase 3 (2020) and 200 million allowances from the MSR. Overall, more than 6 billion allowances are expected to be allocated to industry for free over the period 2021-2030. Moreover, to better align the level of free allocation with actual production levels more flexible rules have been set. Allocations to individual installations may be adjusted annually to reflect relevant increases and decreases in production. The threshold for adjustments was set at 15% and will be assessed on the basis of a rolling average of two years. To prevent manipulation and abuse of the allocation adjustment system, the Commission may adopt implementing acts to define further arrangements for the adjustments. The list of installations covered by the Directive and eligible for free allocation will be updated every 5 years. The 54 benchmark values determining the level of free allocation to each installation will be updated twice in phase 4 to avoid windfall profits and reflect technological progress since 2008. The optional transitional free allocation under Article 10c of the EU ETS Directive will continue to be available to modernise the energy sector in lower-income Member States.

Furthermore, several low-carbon funding mechanisms will be set up to help energy-intensive industrial sectors and the power sector meet the innovation and investment challenges of the transition to a low-carbon economy. The Innovation Fund will support the demonstration of innovative technologies and breakthrough innovation in industry. It will extend existing support under the NER300 programme. The amount of funding available will correspond to the market value of at least 450 million emission allowances.The Modernisation Fund will support investments in modernising the power sector and wider energy systems, boosting energy efficiency, and facilitating a just transition in carbon-dependent regions in 10 lower-income Member States.

The legal status of the renewable energy target has been weakened, as the target of 27% is only binding at EU level[191]. Therefore, the RED will have to be adapted to match the new European target but leave out binding Member State contributions. Nevertheless, it will have to define the national target-setting process (a new element compared to the existing legislation) and revise the reporting requirements. Additionally, a mechanism to measure progress towards the target needs to be implemented and it has to be specified what follows from the identification of a gap. The 2030 energy efficiency target will remain indicative at EU-level with targeted improvements of 27% over a baseline projection. The EED can therefore essentially stay the same regarding target notification and reporting (National Energy Efficiency Action Plans), with adaptations for the new target value. Other instruments, such as the Ecodesign Directive and Eco-Labelling, or the CO_2standards for cars may also be revised before 2020 to provide additional reductions. New policies for other sectors may be developed in the time-frame 2015-2020.[192]

The Commission will evaluate and report annually on progress towards achieving the targets. If any Member State is not on track, they will be required to make an appropriate action plan. To reduce administrative burden and allow for the potential contribution from the land use sector (which has a 5-year compliance period), a comprehensive review of Member States' emissions reports and a more formal compliance check will be organised every 5 years. This closely aligns the proposal with the 5-year review cycle set out in the Paris Agreement. Where a Member State still does not meet its annual obligation in any year, taking into account the use of flexibilities, the shortfall is multiplied by a factor of 1.08 and this penalty is added to the following year's obligation.

A transparent and dynamic governance process will be further developed to help deliver the Energy Union, including the 2030 climate and energy targets, in an efficient and coherent manner. A joined-up approach for the period up to 2030 helps ensure regulatory certainty for investors and coordinate EU countries' efforts. The framework helps drive progress towards a low-carbon economy and build an energy system that ensures affordable energy for all consumers, increases the security of the EU's energy supplies, reduces our dependence on energy imports and creates new opportunities for growth and jobs. It also brings environmental and health benefits through reduced air pollution.

[191] (European Council, 2014)
[192] (climatepolicyinfohub.eu)

Costs do not differ substantially from the costs of renewing an ageing energy system, necessary in any case. Total cost of the energy system in 2030 is projected to increase by an equivalent of 0.15% of the EU's GDP if targets are met cost-effectively. Overall there is a shift from operational costs (fuel) to capital costs (investments). Average annual additional investments are projected to amount to €38 billion for the EU as a whole over the period 2011-30. Fuel savings will to a large extent compensate for these. Lower-income countries need to make relatively larger efforts compared to GDP but European Council conclusions address distribution and include measures to enhance fairness and solidarity while ensuring overall efficiency.[193]

iii. 2050 long-term strategy

The European Commission calls for a climate-neutral Europe by 2050. On 28 November 2018, ahead of the UN climate summit (COP24) from 2 to 14 December in Katowice, Poland, the Commission presented its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050. The strategy shows how Europe can lead the way to climate neutrality by investing into realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research while ensuring social fairness for a just transition ensuring the EU can continue to show leadership and encourage other international partners to do the same. Following the invitations by the European Parliament and the European Council, the Commission's vision for a climate-neutral future covers nearly all EU policies and is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C.[194]

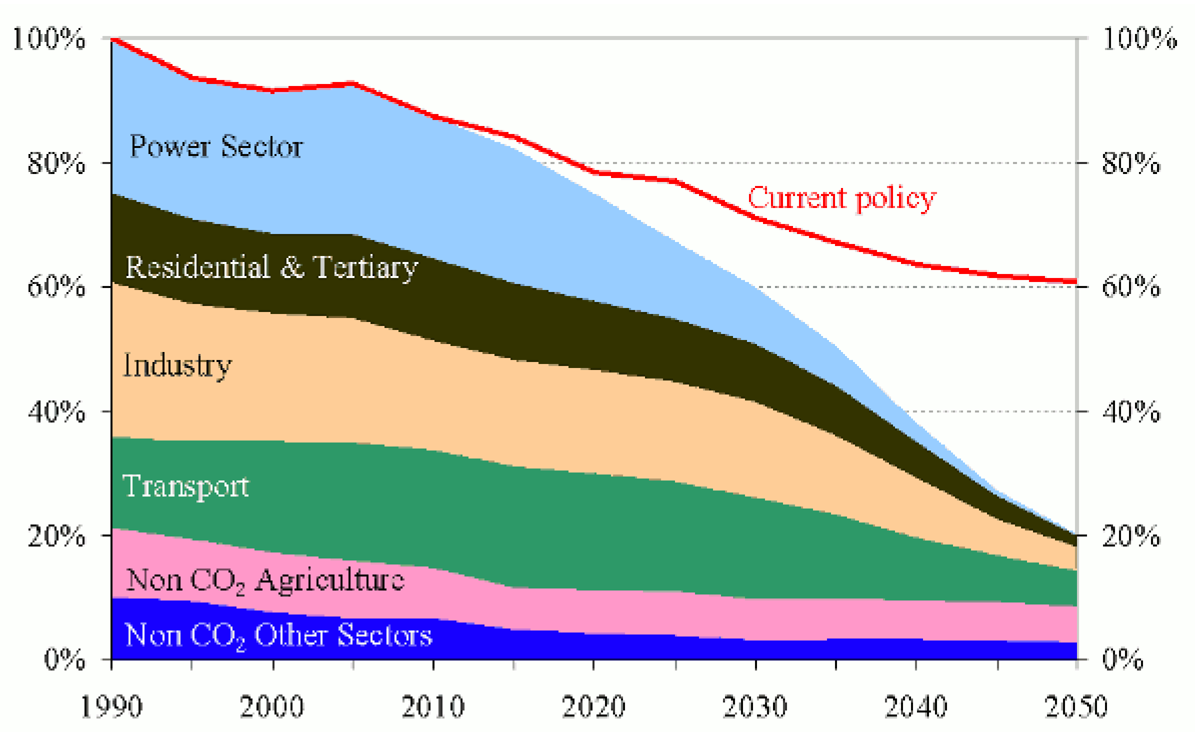
The European Commission is looking at cost-efficient ways to make the European economy more climate-friendly and less energy-consuming. In 2009 the EU renewed its commitment to the goal of keeping global warming below 2°C, over pre-industrial levels[195]. EU Heads of State and Government also formally adopted the objective to reduce emissions by 80-95% by 2050 in comparison to 1990 levels. This target was taken from the IPCC’s Fourth Assessment Report, as the share reflecting historic responsibilities, capacities and projected shares of total global emissions of the EU and other Annex 1 countries[196]. In the Communication entitled “Roadmap to a low carbon economy“[197], published in May 2011, the European Commission elaborated interim reduction targets for domestic GHG emissions for a cost effective pathway to 80-95% reductions in 2050 with three milestones. To get there, Europe's emissions should be 25% below 1990 levels by 2020, 40% below by 2030 (this target was already endorsed as part of the 2030 framework) and 60% below by 2040. Since the EU did not adjust its 2020 target following Copenhagen, the 20% is less than the interim target of the roadmap, causing steeper reduction obligations towards 2050 to reach the 80 to 95% reduction goal.[198] Its low-carbon economy roadmap also suggests that by 2050, the EU should cut greenhouse gas emissions to 80% below 1990 levels through domestic reductions alone (i.e. rather than relying on international credits). This is in line with EU

[193] (Europa)
[194] (Europa)
[195] (European Council, 2009)
[196] (Intergovernmental Panel on Climate Change (IPCC), 2007)
[197] (European Commission, 2011)
[198] (climatepolicyinfohub.eu)

leaders' commitment to reducing emissions by 80-95% by 2050 in the context of similar reductions to be taken by developed countries as a group. To reach this goal, the EU must make continued progress towards a low-carbon society and clean technologies play an important role to this purpose. Early action saves costs later. If we postpone action, we will have to reduce emissions much more drastically at a later stage.

All sectors need to contribute to the low-carbon transition according to their technological and economic potential. Action in all main sectors responsible for Europe's emissions – power generation, industry, transport, buildings, construction and agriculture – will be needed, but differences exist between sectors on the amount of reductions that can be expected. As it appears in Figure 8, the power sector, both its power and distribution segments have the biggest potential for cutting emissions. It can almost totally eliminate CO_2emissions by 2050. Electricity could partially replace fossil fuels in transport and heating. Electricity will come from renewable sources like wind, solar, water and biomass or other low-emission sources like nuclear power plants or fossil fuel power stations equipped with carbon capture & storage technology. This will also require strong investments in smart grids.

Figure 8: Evolution of greenhouse gas emissions in the EU with a 80% decrease target by 2050 (100% =1990).



Source: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Roadmap for moving to a competitive low carbon economy in 2050, https://ec.europa.eu/clima/policies/strategies/2050_en

Furthermore, emissions from transport could be reduced to more than 60% below 1990 levels by 2050. In the short term, most progress can be found in petrol and diesel engines that could still be made more fuel-efficient. In the mid- to long-term, plug-in hybrid and electric cars will allow for steeper emissions reductions. Biofuels will be increasingly used in aviation and road haulage, as not all heavy goods vehicles will run on electricity in future. On the other hand emissions from houses and office buildings can be almost completely cut – by around 90% in 2050. Energy performance will improve drastically through passive housing technology in new buildings, refurbishing old buildings to improve energy efficiency, substituting electricity and renewables for fossil fuels in heating, cooling & cooking. Investments can be recovered over time through reduced energy bills.In addition, energy intensive industries could cut emissions by more than 80% by 2050. The technologies used will get cleaner and more energy-efficient. Up to 2030 and just beyond, CO_2 emissions would fall gradually through further decreases in energy intensity. After 2035, carbon capture & storage technology would be applied to emissions from industries unable to make cuts in any other way (e.g. steel, cement). This would allow much deeper cuts by 2050. Non-CO_2 emissions from industry that are part of the EU emissions trading system are already forecast to fall to very low levels. Finally, as global food demand grows, the share of agriculture in the EU's total emissions will rise to about a third by 2050, but reductions are possible. Agriculture will need to cut emissions from fertilisers, manure and livestock and can contribute to the storage of CO_2 in soils and forests. Changes towards a more healthy diet with more vegetables and less meat can also reduce emissions.

The roadmap[199] concludes that the transition to a low-carbon society is feasible and affordable, but requires innovation and investments. This transition would boost Europe's economy thanks to the development of clean technologies and low- or zero-carbon energy, spurring growth and jobs while helping her reduce its use of key resources like energy, raw materials, land and water. Furthermore it would make the EU less dependent on expensive imports of oil and gas and would bring health benefits through reduced air pollution. To make the transition, the EU would need to invest an additional €270 billion (or on average 1.5% of its GDP annually) over the next 4 decades.

D. Directives

i. Directive 2003/87/EC

The Directive 2003/87/EC (OJ L 275, 25.10.2003, p.32) of the European Parliament and of the Council of 13 October 2003, established a scheme for greenhouse gas emission allowance trading within the Community amending Council Directive 96/61/EC, in order to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner.

ii. Directive 2004/101/EC

The Directive 2004/101/EC (OJ L 338, 13.11.2004, p. 18–23) of the European Parliament and of the Council of 27 October 2004 amended 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.

iii. Directive 2008/101/EC

The Directive 2008/101/EC (OJ L 8, 13.1.2009, p. 3–21) of the European Parliament and of the Council of 19 November 2008 amended Directive 2003/87/EC so as to include aviation

[199] (European Commission, 2011)

activities in the scheme for greenhouse gas emission allowance trading within the Community.

iv. Directive 2009/29/EC (Revision of the EU ETS)

The Directive 2009/29/EC (OJ L 140, 5.6.2009, p. 63–87) of the European Parliament and of the Council of 23 April 2009 amended Directive 2003/87/EC, so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community.

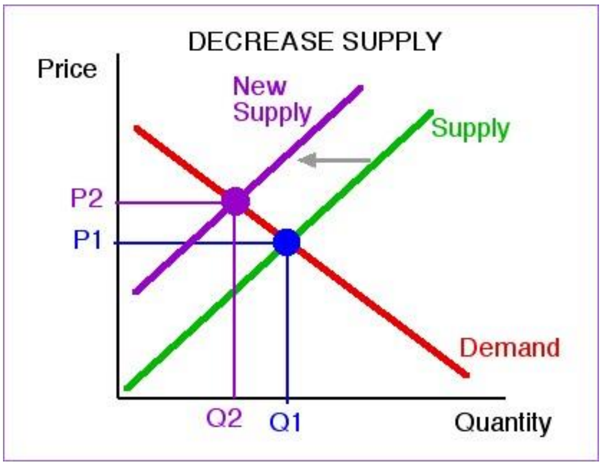
v. Directive 2018/410

The Directive 2018/410 (OJ L.76, 19.03.2018, p. 3–27) of the European Parliament and of the Council of 14 March 2018 amended Directive 2003/87/EC (establishing the EU greenhouse gas Emissions Trading System or ETS) to enhance cost-effective emission reductions, low-carbon investments and Decision (EU) 2015/1814 (Text with EEA relevance), in order to implement the 4th trading period (2021-2030). The new Directive entered into force on 8 April 2018. Member States must transpose the provisions of the Directive into national law by 9 October 2019.

4. *Economic basis*

A. Law of Supply and Demand

Equilibrium in the market can change when demand or supply change. According to the Law of Supply and Demand, Supply can decrease moving the supply curve to the left if costs are higher due to higher resource prices, smaller number of sellers, unfavorable environment for producing or selling or higher taxes. When supply decreases for one of these reasons, it will move the equilibrium, and thus increase the price and decrease the quantity traded of the good.

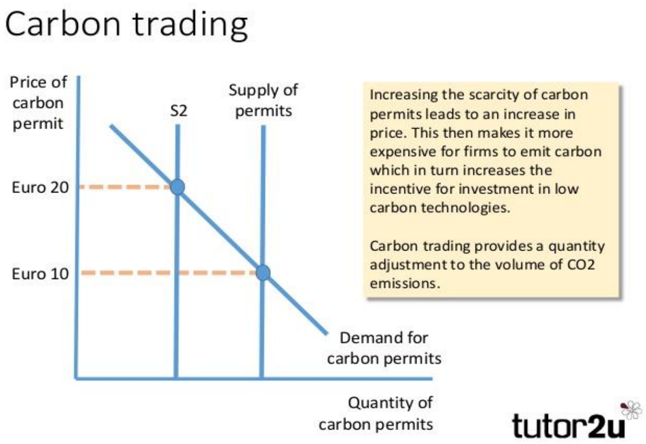


Graph 3: Law of Supply & Demand - decrease in Supply leading to a price increase
Source: Ray Bromley, 2007, pcecon.com Economics Notes and Study Aids, online available at http://www.raybromley.com/notes/equilchange.html

As it appears in the Graph 3, the original equilibrium (with the green supply and red demand) occurs at the price of P1 and quantity (bought and sold) of Q1. As the supply curve moves (to the purple curve), the equilibrium price increases to P2 and the quantity (bought and sold) decreases to Q2. Sellers sell less of the good, but get paid a higher price to sell it.[200]

[200] (Bromley, 2007)

As it was explained above (section II.2Bii) the Law of Supply and Demand is also applied in the case of Emissions Trading System (ETS). As it appears on the Graph 4, increasing the scarcity of carbon permits by shifting the supply curve to the left leads to an increase in price and this makes it more expensive for firms to emit carbon, which in turn increases the incentive for investment in low carbon technologies. Polluters carry out mitigation actions until it is cheaper to buy an allowance on the market than to mitigate a further emission unit. In other words they continue to be environmental friendlier as long as their incentive to pollute is lower than their incentive to invest in RES. As a result, those polluters with the cheapest mitigation options will reduce the most. This theoretically guarantees the most cost effective mitigation pathway for society[201].



Graph 4: Carbon trading
Source: Evaluating Policies to Cut Carbon Emissions, A Level Economics Revision, April 2017, available at https://www.slideshare.net/tutor2u/evaluating-carbon-policies

B. Cap & Trade Principle

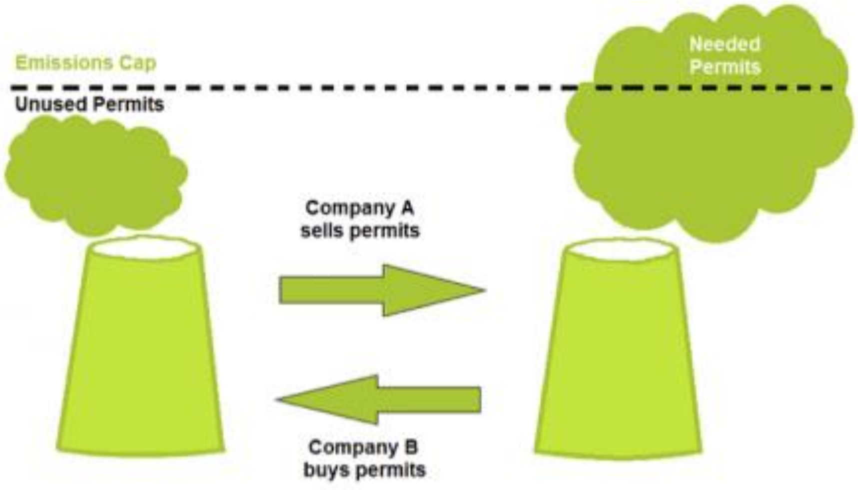
The EU ETS is based on the 'cap and trade' principle. A cap is set as a ceiling on the total maximum amount of certain greenhouse gases that can be emitted by installations covered by the system. It guarantees that total emissions are kept to a pre-defined level and do not rise above it in the period for which the cap applies. Covered installations have to submit an EU Emission Allowance (EUA) for each tonne of carbon dioxide equivalent (CO_2 eq) they emitted during a year. The term EUA describes the carbon credits tradable under the EU ETS. Each EUA unit equals one tonne of CO_2. EUAs are freely allocated or auctioned. Carbon credits are certificates or permits that allow the emission of one tonne of CO2 or one tonne of carbon dioxide equivalent gases (nitrous oxide N2O and perfluorocarbons PFCs). These carbon credits can be traded on national and/or international carbon markets[202].

The cap is reduced over time so that total emissions fall. Within the overall EU wide cap, companies receive or buy EUAs, which they can trade with one another as needed. They can also buy limited amounts of international_credits from emission-saving projects around the world. The limit on the total number of allowances available ensures that they have a value. After each year a company must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances[203]. In other words, as it appears in Figure 9, if companies emit less than the cap, they are permitted to sell the excess carbon permits to companies that are polluting more. The company polluting less will profit from this transaction[204]. Trading brings flexibility that

[201] (Common & Stagl, 2009)
[202] (climatepolicyinfohub.eu)
[203] (Europa)
[204] (climatepolicyinfohub.eu)

ensures emissions are cut where it costs least to do so. A robust carbon price also promotes investment in clean, low-carbon technologies.[205]

Figure 9: Cap and trade Mechanism of the EU ETS



Source: adapted from Energy Royd, 2013, available at: https://climatepolicyinfohub.eu/eu-emissions-trading-system-introduction

EUAs are allocated for free or they are auctioned. The trading system offers flexibility to the businesses covered by the scheme as they can decide on taking action or buying EUAs depending on the EUA price. Emitters who have reduction costs lower than the price are encouraged to take action. Emitters with high reduction costs can buy EUAs and postpone their own action thereby complying with the GHG policy more cheaply than they otherwise would have been able to (if, for example, all emitters had to cut emissions by the same ratio).For accurate tracking of EUAs, participants of the EU ETS open up an account in the Union registry. Anyone possessing an account is able to buy or sell EUAs irrespective of whether they are covered by the EU ETS or not. Trading does not require brokers and can be directly conducted by buyers and sellers through organized exchanges or via intermediaries.[206] Through the implementation of the Cap and Trade prinsciple on the EU ETS the Law of Supply and Demand (Section IV4A) is applied ensuring an increased carbon price and thus incentivizing the required reduction of GHG industrial emissions in the atmosphere and the investment in clean technologies.

The Cap is set by the regulator ex ante, so that the absolute amount of GHG emissions is ex-ante known, as well. As a result the environmental integrity, the correct visibility and the possibility to carry forward unused allowances are ensured for investors. However there is no fine tune of the emission reduction pathway: emissions reduction may not be related to real improvement of carbon intensity. For instance economic crises could lead to a postponing of action.The regulator can also set a baseline (benchmark such as tCO2e/kWh, tCO2e/t, etc.). The EUAs are calculated according to this benchmark, as it appears in the following type: $Carbon\ cost = Carbon\ price\ x\ (volume\ of\ GHG\ emissions - volume\ of\ production\ x\ benchmark)$. In that way, an excellent visibility, an easier allocation, a possibility to carry forward unused allowances are ensured for investors but finally no cap is

[205] (Europa)
[206] (climatepolicyinfohub.eu, n.d.)

set on emissions, monitoring and reporting can become more complex. The regulator can also set an obligation to surrender allowances and eligibility criteria of allowances to be surrendered (like the assessment of the CDM Board in the Kyoto Protocol Mechanism). In that way there is no administrative burden for the State, as emissions reductions are Industry driven, while Environmental integrity is guaranteed. However the drawbacks of No cap on emissions, No link between the offer and the demand and of Technical complexity (eligibility criteria may be biased, e.g. N2O projects) can't be underestimated.[207]

5. *EU ETS - Phases of implementation*

The 1997 Kyoto Protocol set for the first time legally-binding emissions reduction targets, or caps, for 37 industrialised countries. This led to the need for policy instruments to meet these targets. In March 2000, the European Commission presented a green paper with some first ideas on the design of the EU ETS. It served as a basis for numerous stakeholder discussions that further helped shape the system. The EU ETS Directive was adopted in 2003 and the system was launched in 2005[208]. The EU ETS is organised in trading periods (or phases), of which four are currently decided and more may follow. The rules in the first two trading periods (2005-2012) of the EU ETS differed in important respects from those of the current third period (2013-2020). Currently the system is in its third period. Each of the four is described below, as it appears in Table 5.

Table 5: The EU ETS phases

	1. (2005-2007)	2(2008-2012):	3rd (2013 to 2020)
„seriousness“	pilot	1st Kyoto CP	2nd Kyoto CP
coverage	power generators and energy-intensive industrial sectors	also aviation from 2012, also some nitrous oxide	some more sectors and gases; 45% of total greenhouse gas emissions from the 28 EU countries
grandfathering / auctioning	almost completely	at least 90%	progressive rise of auctioning (from 40% in 2013 to 100% by 2027), free allowances allocation under consideration of carbon leaking risks
price	total allocation of EU ETS allowances exceeded demand by a sizeable margin	economic crisis 2008 depressed emissions -> demand -> prices	back-loading as response to low prices (2014: 400 million certificates less)
JI and CDM	yes, but overallocation anyway and inability to bank international credits, no LULUCF	1.4 billion tonnes of CO2-equivalent, no LULUCF	varying percentages for different market participants, difficult to assess percentage, no LULUCF
cap	national	national	EU-wide

Sources: European Commission, Int.Wirtschaftsforum Regenerative Energien, Emissionshandel, Backloading für CO2-Zertificate starlet-Wie reagiert der Preis? (14.10.2014), online https://ec.europa.eu/clima/policies/ets/

Before the start of the phases 1 and 2 of the EU ETS, each EU country decided on the allocation of their emission allowances and the cap on allowances was set at national level through *National Allocation Plans* (NAPs). This process not only established the EU-wide cap in a decentralised, bottom-up way (the sum of the NAPs was the overall cap), but also

[207] (Union for the Mediterranean, 2016)
[208] (Europa)

set the rules for the allocation of allowances for individual installations. Countries had to publish their NAPs by 31 March 2004 (or by 1 May 2004 for the 10 countries which joined the EU in 2004), following guidance from the Commission. The European Commission assessed the plans to ensure they complied with the criteria set out in an annex to the ETS Directive and EU rules on state aid and competition and issued its decisions on the NAPs during 2004-2005. Some plans were amended before the Commission took its decision. In many cases the Commission required changes, in particular to reduce national caps. Its most common objections were these of excessive allocation that jeopardised the achievement of the country's Kyoto target and of the inconsistency of the volume of allowances with the assessment of progress towards the Kyoto target, i.e. the allocation exceeded projected emissions. Once a plan was approved, neither the cap nor the allocation per installation could be changed. The Commission has disallowed intended 'ex-post adjustments' in countries' NAPs, i.e. their plans to intervene in the market after the allocation was done and redistribute the issued allowances among the participating companies[209].

A. Phase 1: 2005-2007

The European Parliament passed a law[210] to set up the EU ETS in October 2003 and regulated the first and second trading phase. The first phase of the EU ETS was a pilot phase of 'learning by doing' to test the system and to be prepared for phase 2, when the EU ETS would need to function effectively to help the EU meet its Kyoto targets. The Member States continued to have the freedom to decide on how many EUAs to allocate in total as well as to each installation in their territory by preparing *National Allocation Plans* (NAPs). Countries had to publish their NAPs by 30 June 2006. The Commission issued its decisions on most NAPs during 2006-2007 but the procedure was proven as a time-consuming one for the countries whose proposed plans had been earlier rejected such as Poland (2010) and Estonia (2011)[211]. Moreover, almost all EUAs were allocated to businesses for free and were based on historic emissions called grandfathering. In this phase, covered CO_2 emissions were only the ones from installations for power and heat generation and in energy intensive industrial sectors like iron, steel, cement and oil refining, etc. The penalty imposed on the companies for non-compliance was 40 Euro per tonne of CO_2[212].

This initial phase succeeded to establish a price for carbon, free trade in emission allowances across the EU and the infrastructure needed to monitor, report and verify (MRV) actual emissions from the covered installations. The market in emission allowances developed strongly from the start. In phase I, trading volumes rose from 321 million allowances in 2005 to 1.1 billion in 2006 and 2.1 billion in 2007, according to the World Bank's annual Carbon Market Reports[213]. According to the International Emissions Trading Association approximately 200 million tonnes of CO_2 or 3% of total verified emissions were reduced due to the ETS at nominal transaction costs[214]. However, as in the absence of reliable emissions data, phase 1 caps were set on the basis of estimates, after the first year of operation, when real world emission data started to be published for the first time, it became obvious that the total amount of allowances issued exceeded emissions and

[209] (Europa)
[210] (EUROPEAN PARLIAMENT & EUROPEAN COUNCIL, 2003)
[211] (Europa)
[212] (climatepolicyinfohub.eu)
[213] (Europa)
[214] (climatepolicyinfohub.eu)

that too many EUAs had been allocated to businesses, leading to an oversupply of EUAs and a consequent fall in their price, eventually to zero in 2007[215].Supply significantly exceeded demand as phase 1 allowances could not be banked for use in phase 2.

B. Phase 2: 2008-2012

Since phase two was concurrent with the first commitment period of the Kyoto Protocol, where the countries in the EU ETS had concrete emissions reduction targets to meet (see section IV.3.A.i.), the EU imposed a tighter emission cap by reducing the total volume of EUAs by 6.5% compared to 2005. Moreover, lessons learned from the very complex and time-consuming process for phase 1 NAPs has contributed to the improvement of the process for phase 2. In its guidance document, the Commission emphasised the need to make the plans simpler and more transparent by encouraging countries to review the administrative rules created in their first plan and by drawing up standardised tables to summarise key information. However, several Commission Decisions on NAPs continued to be challenged by Member States. In phase 2 many of the proposed caps were subsequently reduced while from 2012 the Union registry replaced the national ones and the European Union Transaction Log (EUTL) replaced the Community Independent Transaction Log (CITL). Avoiding this legal uncertainty constituted one of the factors influencing the decision to use an EU-wide cap for phase 3. Moreover, in this phase Iceland, Norway and Liechtenstein joined the EU ETS and the scope was amended to include nitrous oxide from nitric acid production from several Member States. In addition, the aviation sector was brought into the EU ETS on 1 January 2012 and from this date onwards the scheme included flights within the borders of the EU ETS countries (application for flights to and from non-European countries was suspended for 2012). The proportion of free allocation fell slightly to around 90% and up to 10% of the allowances instead of free allocation could be auctioned by the Member States. The penalty for non-compliance rose to 100 Euro per tonne of CO_2 equivalent[216].

In phase 2 businesses were also allowed to buy international credits from the Kyoto Protocol’s Clean Development Mechanism (CDM) and Joint Implementation (JI) leading to a total of 1.4 billion tons of CO_2-equivalent credits on the market with the exception of those for nuclear facilities, agricultural and forestry activities[217]. This move was meant to offer cost-effective mitigation options to businesses and it made the EU ETS the main driver of the international carbon market. In addition, because verified annual emissions data from the pilot phase was now available, the cap on allowances was reduced in phase 2, based on actual emissions. However, the additional credits from the international market and the ones due to economic crisis of 2008, which reduced economic activity and consequently EU companies’ emissions in a greater than expected way, resulted in a large surplus of allowances and credits, causing a new fall of the price throughout phase II from 30 Euro to less than 7 Euro. Figure 10 illustrates how the prices of EUAs have fluctuated over the years and how it fell to zero at the end of phase 1 and during the peak of the economic crisis[218].

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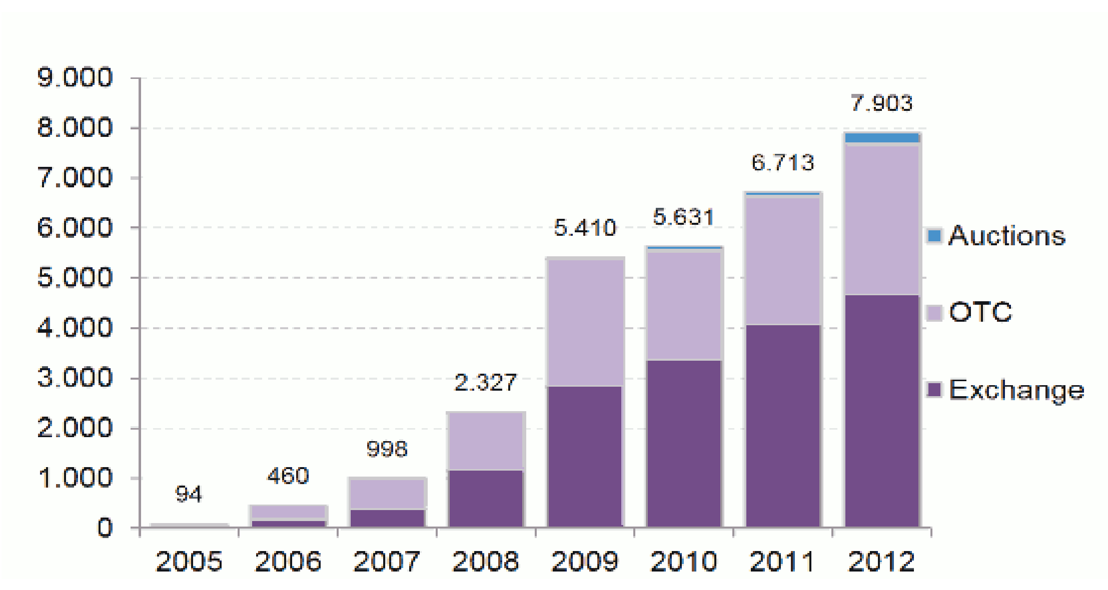
215 (European Commission , 2014)
216 (Europa)
217 (European Commission , 2014)
218 (climatepolicyinfohub.eu)

Figure 10: Price per EUA in Euro 2005-2011

Source: European Environment Agency (2014), available at https://climatepolicyinfohub.eu/eu-emissions-trading-system-introduction

The EU ETS remained the main driver of the international carbon market during phase 2. In 2010, for example, EU allowances accounted for 84% of the value of the total global carbon market. Trading volumes jumped from 3.1 billion in 2008 to 6.3 billion in 2009. In 2012, 7.9 billion allowances were traded (worth €56 billion). Daily trading volumes exceeded 70 million in mid-2011(Figure 11)[219].

Figure 11: Trading volumes in EU emission allowances (in millions)



Source: Bloomberg New Energy Finance. Figures taken from Bloomberg, ICE, Bluenext, EEX, GreenX, Climex, CCX, Greenmarket, Nordpool. Other sources include UNFCCC, Bloomberg New Energy Finance and London Energy Brokers Association estimations, at: https://ec.europa.eu/clima/policies/ets/pre2013_en

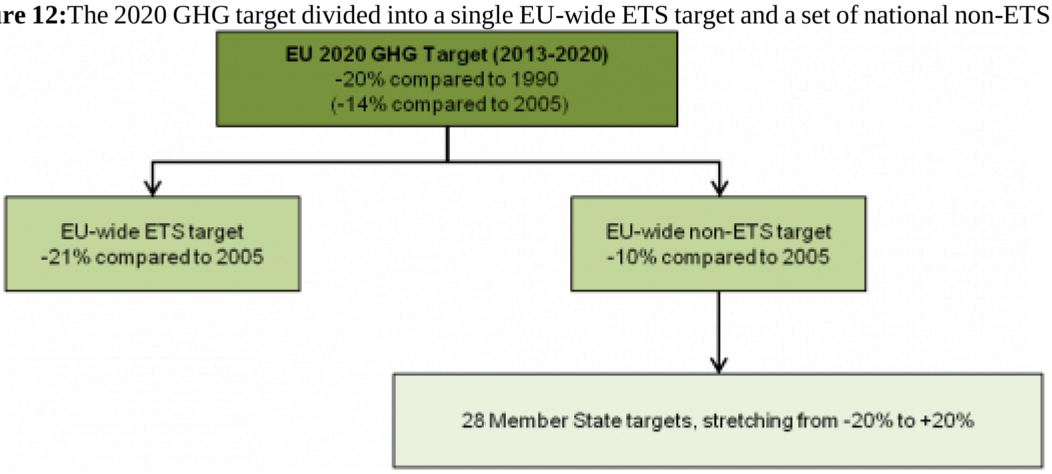
[219] (Europa)

C. Phase 3: 2013-2020

The system's crash due to the fall of carbon price near to zero providing incentives to industries to pollute, was commanding its reform. The EU ETS is now in its third phase, which is significantly different from phases 1 and 2.The European Commission in 2009 revised the EU ETS for the third phase[220]. The reasons for these modifications were manifold. Firstly, the fall of EUAs during phase two greatly undermined its reliability. Secondly, the EU ETS did not generate substantial transformations or movement towards renewable energy industries or low carbon technologies as was expected. Thirdly, it was not as cost-effective as initially anticipated. Lastly, it was subjected to several frauds and scams.

To deal with the inherent weaknesses of the system, the changes introduced in this phase particularly include the emission cap setting centrally and applying uniformly over the EU to achieve the GHG reduction target more effectively. In addition, the revised ETS was extended to new sectors (aviation) or to new GHGs (besides carbon dioxide, the EU ETS also covers nitrous oxides and perfluorocarbons). As shown in Figure 12, the amendment of the ETS Directive introduced a *single EU-wide emissions cap* for emissions from power and industrial installations applying in place of the previous system of national caps**,** thereby effectively abolishing national targets in these sectors. The cap for 2013 from fixed installations was set at 2,084,301,856 allowances. During phase 3, this cap decreases annualy by a *linear reduction factor of 1.74%* of the average total quantity of allowances issued annually in 2008-2012. This amounts to a reduction of 38,264,246 allowances each year.The linear reduction factor was set in line with the EU-wide climate action targets for 2020 – the overall 20% emissions reduction target and the EU ETS sector-specific 21% emissions reduction target relative to 2005[221].The year 2005 is used as a reference one as it is the first year where a split of ETS and non-ETS emissions data was available[222]

Figure 12: The 2020 GHG target divided into a single EU-wide ETS target and a set of national non-ETS targets



Source: EEA, "Greenhouse Gas Emission Trends and Projections in Europe 2012", Tracking progress towards Kyoto and 2020 targets, EEA report No. 6 (Copenhagen: EEA, 2012), page 55. Online available at: http://www.eea.europa.eu//publications/ghg-trends-and-projections-2012

Following the revision of the ETS Directive in 2009, EU ETS operations were in 2012 also centralised in a *single EU registry* operated by the European Commission. The Union

[220] (European Parliament and Council, 2009)
[221] (Europa)
[222] (climatepolicyinfohub.eu)

registry serves to guarantee accurate accounting for all allowances issued under the EU ETS. It keeps track of the ownership of allowances held in electronic accounts, just as a bank has a record of all its customers and their money. It covers all 31 countries participating in the EU ETS and as an online database it holds accounts for stationary installations (transferred from the national registries used before 2012) and for aircraft operators (included in the EU ETS since January 2012) as well. More specifically the registry records national implementation measures (a list of installations covered by the ETS Directive in each EU country and any free allocation to each of those installations in the period 2013-2020), accounts of companies or individuals holding such allowances, transfers of allowances (*"transactions"*) performed by account holders, annual verified CO2 emissions from installations and aircraft operators, annual reconciliation of allowances and verified emissions, where each company must have surrendered enough allowances to cover all its verified emissions[223].

In phase 3 the default method for allocating allowances was modified from grandfathering to auctioning. This means that businesses have to buy an increasing proportion of allowances through auctions. Auctioning is the most transparent allocation method and puts into practice the *principle that the polluter should pay*. Pursuant to Article 10(1) of the ETS Directive, Member States have their own shares in the auctioning volume. More specifically 88% of the allowances to be auctioned in 2013 to 2020 are distributed to the EU Member States on the basis of their share of verified emissions from EU ETS installations in 2005 or the average of the 2005-2007 period, whichever one is the highest while 10% are allocated to the least wealthy EU member states as an additional source of revenue to help them invest in reducing the carbon intensity of their economies and adapting to climate change. So as to fund the deployment of innovative renewable energy technologies and carbon capture and storage, 300 million allowances were set aside in the New Entrants Reserve (NER) 300 programme. The remaining 2% is given as a 'Kyoto bonus' to nine EU Member States which by 2005 had reduced their GHG emissions by at least 20% of levels in their base year or period. These are Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia. The three EEA-EFTA countries will also auction allowances in accordance with the same principles as the EU Member States[224].

The auctioning platforms are accessible to any country that participates in the EU ETS although the auctions take place at a national level[225].The auctioning of allowances is governed by the EU ETS Auctioning Regulation. This covers the timing, administration and other aspects of auctioning to ensure it is conducted in an *open, transparent, harmonised and non-discriminatory* manner.The Auctioning Regulation seeks to put into practice a number of criteria which the revised EU ETS Directive states auctions must meet, such as predictability, cost-efficiency, fair access to auctions and simultaneous access to relevant information for all operators. The Auctioning Regulation provides for the Member States and the Commission to procure jointly a common platform to auction emission allowances on behalf of the Member States.This is the most cost-efficient approach for Member States and bidders alike. The Commission considers that a common platform also best ensures respect of the *principles of non-discrimination, transparency and simplicity*, provides the best guarantees for *full, fair and equitable access* to small and medium sized enterprises and small emitters covered by the EU ETS, and best *minimises the risk of market abuse*.

[223] (Europa)
[224] (Europa)
[225] (European Commission , 2014)

Following a competitive tender procedure carried out under a joint procurement agreement, the Commission and 25 Member States re-appointed the European Energy Exchange (EEX) and its clearing system, the European Commodity Clearing (ECC) as common auction platform for these Member States. The contract with EEX entered into force on 13 July 2016[226].

The revised EU ETS Directive in article 10(3) provides *that "at least 50 % of auctioning revenues or the equivalent in financial value of these revenues should be used by Member States for climate and energy related purposes"*.Under the Monitoring Mechanism Regulation, Member States are requested to report annually (for the first time by 31 July 2014) on the amounts and use of the revenues generated (article 17 of Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013). Member States have generated nearly € 15.8 billion from the auctioning of EU ETS allowances over the period 2013-2016. Based on the most recent information available, in 2013, more than 80% of the total revenues for the EU (€3.6 billion), around €3 billion has been used for climate and energy related purposes such as energy efficiency, renewables, research and sustainable transport, significantly more than the 50% level recommended in the EU ETS Directive[227].

Auctioning is now the default method for allocating emission allowances to companies participating in the EU ETS. However, in sectors other than power generation, the transition to auctioning is taking place progressively. Some allowances continue to be allocated for free until 2020 and beyond. Allowances not allocated for free are to be auctioned. Given the significant weight of power generation in the EU ETS, and even with partial free allocation in eight Member States, more than 40% of the 2013 annual allowances were auctioned whereas in the second trading period (2008-2012), no more than 4% of the allowances were auctioned. This share will increase in the following years, as the volume of allowances allocated for free decreases faster than the cap. Over the current trading period (2013–2020), the Commission estimated that 57% of the total amount of allowances will be auctioned, while the remaining allowances will be available for free allocation[228].

At the beginning of the current trading period (2013), manufacturing industry received 80% of its allowances free of charge, but this proportion will decrease gradually each year down to 30% in 2020, for sectors other than the ones deemed to be exposed to carbon leakage. Sectors and sub-sectors facing competition from industries outside the EU that are not subject to comparable climate legislation will receive more free allowances than those which are not at risk of this carbon leakage. More specifically, industries at risk of carbon leakage, determined as those by the Commission, would receive 100% of free allocation over the whole trading period. The continuation of free allocation allows the EU to pursue ambitious emissions reduction targets while shielding internationally competing industry from carbon leakage. The continued provision of some free allowances limits costs for EU industry in relation to non-EU competitors. As far as the aviation sector is concerned, Airlines continue to receive the large majority of their allowances for free in the period 2013-2020 while just a percentage of 15% of allowances in circulation is auctioned[229].

[226] (Europa)
[227] (Europa)
[228] (Europa)
[229] (Europa)

On the other hand, as it is already mentioned since 2013 power generators in principle no longer receive any free allowances, but have to buy them. The experience of the first two trading periods showed that power generators have been able to pass on the "*notional"* cost of allowances to final consumers even when they received them for free. However, some free allowances are available to modernise the power sector in some Member States. More specifically eight of the Member States which have joined the EU since 2004 – Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania – have made use of a derogation under *Article 10c of the EU ETS Directive* which temporarily allows them to give a decreasing number of free allowances to existing power plants for a transitional period until 2019. Latvia and Malta were also eligible to use this derogation but chose not to. The overall amount invested had to match or exceed the value of the allowances allocated for free. As a result, in return for transitional free allocation, the 8 countries concerned have drawn up plans setting out investments to be financed through the free allocation with a view to diversifying their energy mix (RES) and modernising their electricity sectors by retrofitting and upgrading their infrastructure (clean technologies).The rules for the free allocation, set out in the ETS Directive, were complemented by the 'derogation package' adopted in 2011[230]. Greece also tried to make use of this derogation but it was judged as an ineligible member state (see section VIII2).

Free allocation applies to industrial installations other than the ones for power generation based on *benchmarks (BMs)* that reward most efficient installations in each sector. A BM determines the number of free EUAs based on the installation's output (or input)[231]. The current 54 benchmarks (52 products such as for steel, cement or lime and 2 so-called fallback approaches based on heat and fuel) were elaborated based on extensive technical work. Generally speaking, a product benchmark is based on the average GHG emissions of the best performing 10% of the installations producing that product in the EU.The benchmarks are based on the principle of 'one product = one benchmark'. This means that the methodology does not vary according to the technology or fuel used, the size of an installation, or geographical location. Installations that meet the benchmarks, and are therefore some of the most efficient in the EU, in principle receive all the allowances they need to cover their emissions. Installations that do not reach the benchmarks receive fewer allowances than they need, in order to be incentivised to reduce their emissions instead of buying additional allowances or credits to cover them. Free allocations were determined by multiplying the benchmark by the verified emissions data of each eligible operator who has submitted their application. EU-wide harmonised rules for free allocation are set out in the European Commission's 2011 Benchmarking Decision. As the requested allocations for all installations in the EU exceeded the total amount available for free allocation, the allocation per installation was reduced for all installations by the same percentage. This is the cross-sectoral correction factor applied as from 2013. The correction factor reduced allocation by around 6% in 2013. As the amount of allowances available decreases each year, the correction factor increases each year until 2020 when it will reach approximately 18%. Moreover, the amount of free allowances can change throughout the period 2013-2020 due to production and capacity adjustments beyond the thresholds fixed in the harmonised allocation rules[232].

[230] (Europa)
[231] (climatepolicyinfohub.eu)
[232] (Europa)

But the main challenge in the third trading period (2013-2020) was the large imbalance between the supply and demand of allowances. A surplus of EUAs has already built up since the second trading period (2009) leading to a EUA price of only 3-7 Euro. The surplus of allowances is largely due to the economic crisis (which reduced emissions more than anticipated) and high imports of international credits. This has led to lower carbon prices and thus a weaker incentive to reduce emissions. In the short term, the surplus risks undermining the orderly functioning of the carbon market. In the longer term it could affect the ability of the ETS to meet more demanding emission reduction targets cost-effectively. Therefore the European Commission is addressing this structural weakness of the system through short and long-term measures. Firstly, it decided to postpone the auctioning of 900 million EUAs until 2019-2020. This act, the so-called *backloading* of auction volumes does not reduce the overall number of allowances to be auctioned during phase 3 but only the distribution of auctions over the period. More spesifically the auction volume was reduced by 400 million allowances in 2014, by 300 million in 2015 and by 200 million in 2016. This measure rebalanced supply and demand in the short term and reduced price volatility without any significant impacts on competitiveness. It was implemented through an amendment to the EU ETS Auctioning Regulation, which entered into force on 27 February 2014. As a consequence of back-loading the surplus amounted to around 2.1 billion allowances in 2013, fell slightly in 2014 and was significantly reduced in 2015 to around 1.78 billion. Without this, the surplus would have been almost 40% higher at the end of 2015[233]. However, as emissions declined by around 2, 9% in 2016, lower demand partly balanced the impact of the further reduction of the EUAs'supply in 2016, the final year of the back-loading measure, to 1.69 billion allowances, on the surplus[234].

As a structural solution, a *Market Stability Reserve (MSR)* was agreed in 2015 to render the auction supply of emission allowances more flexible, so as for the European carbon market to be stabilised in the longer term. It will start operating in January 2019. The reserve will address the structural imbalance between the supply and demand of allowances, the current surplus of allowances and it will improve the system's resilience to major shocks by adjusting the supply of allowances to be auctioned. The 900 million allowances that were back-loaded in 2014-2016 will be transferred to the reserve rather than auctioned in 2019-2020. Unallocated allowances, i.e. allowances remaining in the NER300, allowances foreseen for free allocation to installations unallocated because of (partial) cessation of operations or significant capacity reductions and *de facto unallocated* allowances relating to sectors not included in the carbon leakage list during the current period[235], will also be transferred to the reserve. The exact amount will only be known in 2020. However, market analysts estimate that around 550 to 700 million allowances could remain unallocated by 2020[236]. The reserve will operate entirely according to pre-defined rules that leave no discretion to the Commission or Member States in its implementation. Each year, the Commission will publish by 15 May the *Total Number of Allowances in Circulation (TNAC)*. Allowances will be added to the reserve, if the TNAC is above a predefined upper threshold (833 million allowances) and will be released from the reserve, if the number is below a predefined lower threshold (below 400 million allowances) [237]. Efforts to address the market imbalance would also be helped by a faster reduction of the annual emissions cap. In this context, discussions are currently being held in the Council and the European Parliament on

[233] (Europa)
[234] (EUROPEAN COMMISSION, 2017)
[235] (EUROPEAN COMMISSION, 2017)
[236] (Europa, n.d.)
[237] (EUROPEAN COMMISSION, 2017)

temporarily doubling the rate at which allowances will be placed in the reserve[238]. However, as it is argued both backloading and the Market Stability Reserve only temporarily remove surplus from the market but they don't decrease the total emissions budget and therefore do not lead to a more ambitious target[239].

D. Phase 4: After 2020

This phase will begin 1 January 2021 and finish on 31 December 2028 wherein the EC intends to conduct a full review of the EU ETS Directive by the year 2026[240].In January 2014, the European Commission presented a legislative proposal to revise the EU ETS for the period after 2020. This was submitted to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions for further consideration under the ordinary legislative procedure. In October 24, 2014, the European Council approved the 2030 Framework for Climate and Energy. The decision was formed well in advance of the Paris Climate Conference, in order to facilitate the submission of the EU's offer by early 2015. The EU was the second party, after Switzerland, to submit their INDC to the UNFCCC Secretariat, on March 6th 2015[241]. After extensive negotiations, the European Parliament and the Council formally supported the revision in February 2018. The revised EU ETS Directive (Directive (EU) 2018/410)[242] entered into force on 8 April 2018. In the context of each global stocktake under the Paris Agreement, the provisions of the revised EU ETS Directive will be kept under review. The first global stocktake will take place in 2023.

In February 2018, the legislative framework of the EU ETS for its next trading period (phase 4) was revised to enable it to achieve the EU's 2030 emission reduction targets in line with the 2030 climate and energy policy framework and as part of the EU's contribution to the 2015 Paris Agreement [243].To achieve the EU's overall GHG emissions reduction target for 2030 to 40% below 1990 levels, the sectors covered by the EU ETS must reduce their emissions by 43% compared to 2005 levels[244]. According to available data, over the period during which lawmakers voted on and approved the reforms to the EU ETS, the price of EUAs increased from €5/tCO2e (US$7/tCO2) on August 1, 2017 to €13/tCO2e (US$16/tCO2) on April 1, 2018[245]. The revised EU ETS Directive, which will apply for the fourth trading period (2021-2030), will enable this through a mix of interlinked measures.

Firstly the revision focuses on strengthening the EU ETS for the next decade as an investment driver by increasing the pace of annual reductions in allowances as of 2021 and by reinforcing the Market Stability Reserve. To increase the pace of emissions cuts, the cap on emissions will be subject to an annual linear reduction factor of 2.2% from 2021 onwards, compared to 1.74% currently, in line with the 2030 targets – the overall -40% emissions reduction target and the EU ETS specific -43% emissions reduction target relative to 2005. The increased reduction factor of -2.2%, results in an annual reduction of 48,380,081 emission allowances, in the period 2021-30. Around 38 million allowances have been issued

[238] (Europa)
[239] (Climate Action Network Europe, 2016)
[240] (climatepolicyinfohub.eu)
[241] (UNFCCC, 2015)
[242] (European Parliament and Council , 2018)
[243] (Council of the European Union, 2018)
[244] (European Commission, 2014)
[245] (European Energy Exchange, 2018)

to the aviation sector annually since 2013, following a reduction in scope to apply to flights within the European Economic Area. This is considerably below the actual verified CO_2 emissions from such flights, which have increased from 53.5 million tonnes CO_2 in 2013 to 64.2 million tonnes in 2017. From 2021 onwards, the same linear reduction factor that applies to stationary installations, will apply to these allocations too. EU leaders have decided that during the next decade 90% of the allowances to be auctioned will be distributed to the EU Member States on the basis of their share of verified emissions, and 10% will be allocated to the less wealthy EU Member States for the purposes of solidarity, growth and interconnections[246]. Moreover, the Market Stability Reserve (MSR) - the mechanism established by the EU to reduce the surplus of emission allowances in the carbon market and to improve the EU ETS's resilience to future shocks – will be substantially reinforced, as from 2019 until 2023, the yearly withholding rate of surplus allowances into the reserve will double to 24%. The regular feeding rate of 12% will be restored as of 2024. As a long-term measure to improve the functioning of the EU ETS, and unless otherwise decided in the first review of the MSR in 2021, from 2023 onwards the number of allowances held in the MSR will be limited to the previous year's auction volume and any allowances beyond that number will be invalidated[247].

In the context of the 2030 climate and energy framework, EU leaders decided in October 2014 that free allocation shall not expire, but the share of allowances to be auctioned will not reduce during the next decade. The revised EU ETS Directive provides predictable, robust, fair, better targeted rules to address the risk of carbon leakage. The system of free allocation will be prolonged for another decade as a safeguard for the international competitiveness of industrial sectors (others than the power sector, which from 2013 no longer receives free allowances) at such risk, revised so as to focus on sectors at the highest risk of relocating their production outside of the EU. These sectors will receive 100% of their allocation for free up to benchmark levels. For less exposed sectors, free allocation is foreseen to be phased out after 2026 linearly from a maximum of 30% to 0 at the end of phase 4 (2030).A considerable number of free allowances will be set aside for new and growing installations. This number consists of unallocated allowances from the total amount available for free allocation by the end of phase 3 (2020) and 200 million allowances from the MSR. In the aviation sector, the EU extended the "Stop the Clock" provision in December 2017. Under this extension, intercontinental flights are not included in the scope of the EU ETS until December 31, 2023 to align with the start of the first phase of CORSIA in 2024[248].

More flexible rules have been also set so as to better align the level of free allocation with actual production levels. Allocations to individual installations may be adjusted annually to reflect relevant increases and decreases in production. The threshold for adjustments was set at 15% and will be assessed on the basis of a rolling average of two years. To prevent manipulation and abuse of the allocation adjustment system, the Commission may adopt implementing acts to define further arrangements for the adjustments. The list of installations covered by the Directive and eligible for free allocation will be updated every 5 years. The 54 benchmark values determining the level of free allocation to each installation will be updated twice in phase 4 to avoid windfall profits and reflect technological progress since 2008. Finally, the need to improve transparency was particularly emphasized, so that free allocation is used to support real investments. This is reflected in the proposal for the revision of the EU ETS, which provides for the selection of

[246] (Europa)
[247] (Europa)
[248] (European Commission, 2017)

large investments by means of a competitive bidding process, instead of a national investment plan that fixes investments for the entire period. Overall, more than 6 billion allowances are expected to be allocated to industry for free over this trading period[249].

Furthermore, several low-carbon funding mechanisms will be set up to help energy-intensive industrial sectors and the power sector meet the innovation and investment challenges of the transition to a low-carbon economy. Firstly, the Innovation Fund will provide financial support to the demonstration of innovative technologies and breakthrough innovation projects in energy-intensive industry, renewable energy and carbon capture and storage/utilization extending existing support under the NER300 programme. This fund will be financed by the sale of 400 million EUAs while 50 million unallocated EUAs from Phase 3 (2013–2020) will be also set aside for this fund. In addition, the optional transitional free allocation under Article 10c of the EU ETS Directive will continue to be available to modernise the energy sector in lower-income Member States. The Modernisation Fund will support investments in modernising the power sector and wider energy systems, boosting energy efficiency, and facilitating a just transition in carbon-dependent regions in 10 lower-income Member States. It will be financed by two percent (2%) of the total auctioned allowance proceeds. After 2025, more allowances may be added to both funds, in case these allowances are not needed to prevent a cross-sectoral correction factor. [250]

[249] (Europa)
[250] (World Bank Group & Ecofys, 2018, pp. 45-46)

V. Can a market-based policy instrument be fully substituted for regulation? – Market failures and suggested solutions

In theory the ETS is a successful mechanism, which uses the free market's function according to the Law of Supply and Demand, as applied automatically by rational market players to reduce world pollution, based on Adam Smith's theory about the "Invisible hand" of market forces[251]. Developed world companies are financially encouraged to help developing world companies clean up their manufacturing processes by purchasing carbon credits from manufacturers in the developing world. In practice, however, there are loopholes, referred also as market failures that seriously threaten the scheme's credibility.

The ETS has been accused of taking into account only greenhouse gases while staying indifferent about other forms of pollution, of using money made through trading credits to expand businesses and as a result increasing pollution and for lack of transparency, scrutiny and accountability as its auditors paid by the audited companies in many cases don't make on-site visits, and largely base their controls on information the companies themselves provide. Carbon credits, as financial instruments have been also accused for market speculation, as a consequence of their significant profitability before the great recession while during the economic crisis they dropped to such a low level that they ended up even incentivizing pollution fully cancelling their initial purpose[252]. In the following paragraphs there is a thorough description of all the scheme's weaknesses, which as pointed out dring the passage of years, lead to its effective progress.

1. *Carbon Leakage*

According to William Nordhaus' assumption *"Although the net impact of policies is relatively small, the total discounted climatic damages are large. This presupposes that carbon prices are harmonized across sectors and countries, that there are no exemptions or favored sectors, and that the time path of carbon prices is correctly chosen. All of these are unrealistic in the world we know today"* [253]. According to his thorough description the high costs of limited participation apply with equal force in the Kyoto Protocol. Different Carbon prices across countries (from high to zero), favored sectors within covered countries, no mechanism to guarantee an efficient allocation over time, policies that focus on small slices of the economy, such as fuel-economy standards for the automobile industry, all of them are presented as characteristics of a dysfunctional system. What's more, *"if half the economy with average emissions intensities is exempted because of political concerns with farmers, the poor, labor unions, powerful lobbies, or international competitiveness, then the cost of attaining a climatic objective will also have a cost penalty of 250 percent"*. As he estimates, *"the present value of climatic damages in the realistic case is $22.6 trillion, compared with $17.3 trillion in the optimal case"*[254]. According to Branger & Quirion's conclusions, the bigger the *abating coalition,* the smaller the leakage rate while the more ambitious the target, the higher the leakage. Linking carbon markets within the abating coalition, authorizing

[251] (Smith, 1776)
[252] (Ghouri, 2009)
[253] (Nordhaus, 2008, p. 197)
[254] (Nordhaus, 2008, pp. 195-198)

offset credits or extending carbon pricing to all GHG would increase economic efficiency and would reduce leakage[255].

Carbon leakage refers to the situation that may occur if, for reasons of additional costs related to pollution abatement policies, businesses relocate their production to other countries with laxer emission constraints**[256]**. Empirical studies have focused on *operational leakage* and not on *investment leakage* (change in production capacities), which could be studied through the analysis of foreign direct investments. It can be measured by the leakage rate or leakage-to-reduction ratio, which is the rise in emissions in the rest of the world divided by the abated emissions in the region that has adopted a climate policy. A 50% leakage-to-reduction ratio means that half of the mitigation effort is undermined by the increase of emissions in the rest of the world. If this ratio is under 100%, emissions have decreased on a global scale, so the policy is environmentally beneficial. Carbon leakage occurs through two main channels: the competitiveness channel and the international fossil fuel price channel, as described below. [257]

As a result of carbon leakage, there is no net reduction of emissions as the emissions simply occur elsewhere.[258]As it is argued this can lead to an increase of global emissions, therefore undermining the Kyoto Protocol objective of reducing GHG emissions[259]. Aichele and Felbermayr econometrically assessing the impact of developed countries' emission target under the Kyoto Protocol on their CO2 footprint, concluded that countries with a Kyoto target reduced domestic emissions by about 7% between 1997-2000 and 2004-2007 compared to the countries without a target, but that their CO2 footprint did not changed, as at the same time CO2 net imports increased by about 14 %[260]. These results imply that domestic reductions have been fully offset by carbon leakage.This conclusion invites us also to look directly at the impact of the EU ETS, the largest carbon pricing experiment so far[261].

A. International Fossil Fuel Price Channel - Green Paradox (GP)

Abating countries almost necessarily have to cut their fossil fuel consumption, which drives down the international prices of carbon-intensive fossil fuels. This decrease in prices reduces the net cost of climate policies in fuel-importing abating countries since a part of abatement is born by fossil fuel exporters who lose a part of their rents. However it leads to a rise of their consumption in countries with less stringent policies. Because of international energy markets, the shrink in consumption in one region involves an increase in consumption in the rest of the world, causing carbon leakage through the international fossil fuel price channel[262]. Countries that do not partake of the efforts to curb demand have a double advantage. They burn the carbon set free by the "green" countries (*leakage effect*) and they also burn the additional carbon extracted as a reaction to the announced and expected price cuts resulting from the gradual greening of environmental policies[263]. The same reasoning applied to the whole world but with two temporal periods is known as the *Green Paradox*

[255] (Branger & Quirion, 2014/02/01, pp. 53-71)
[256] (European Commission)
[257] (Branger & Quirion, 2014/02/01, pp. 53-71)
[258] (climatepolicyinfohub.eu, n.d.)
[259] (Marcu, et al., 2013)
[260] (Aichele & Felbermayr., 2012)
[261] (Branger & Quirion, 2014/02/01, pp. 53-71)
[262] (Branger & Quirion, 2014/02/01, pp. 53-71)
[263] (Burniaux & Oliveira Martins , 2000)

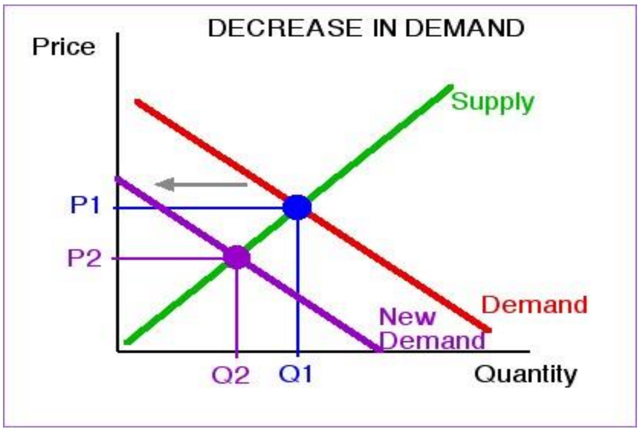
which could be considered as inter-temporal leakage: a rising CO2 price would be seen as a future resource expropriation by fossil fuel owners who would then increase resource extraction. Fossil fuel supply elasticities indicate to what extent a decrease in fossil fuel demand reduces the fuel price causing carbon leakage through the international fossil fuel price channel[264].

Politicians seek to solve the problem of global warming by a myriad of measures aimed at reducing CO2 emissions, which are, in fact, measures to reduce carbon demand, ranging from taxes on fossil fuel consumption to the development of alternative energy sources. However, green demand-reducing measures cannot reasonably be proposed as a means to mitigate the the problem of global warming, as they are unlikely to flatten the carbon supply path that wealth maximizing resource owners choose. To the opposite, they increase their incentive to extract because the anticipated demand and price decline that these policies generate in the future reduces the opportunity cost of the resource in situ. If the measures reduce the discounted value of the carbon price in the future more than in the present, the problem of global warming will be even exacerbated, because resource owners will have an incentive to anticipate the price cuts by extracting the carbon earlier[265].

Hans-Werner Sinn, German economist, in his controversial book descrided his theory about Green Paradox writes emphasizing that: *"Demand reduction strategies simply depress the world price of carbon and induce the environmental sinners to consume what the Kyoto countries have economized on. Even worse, if suppliers feel threatened by a gradual greening of economic policies in the Kyoto countries that would damage their future prices, they will extract their stocks more rapidly, thus accelerating global warming"*[266] .He also argued that: *"The demand policies emphasized in the public debate are useless if the supply path of carbon is fixed. Alternative ways of generating energy, carbon taxes or attempts to reduce the energy intensity of economic activities are all futile if the sheiks do not participate in the game. One country's green policies just help the other country buy energy at lower prices, and the speed of global warming is unchanged"*[267]. He characterizes a green policy paradox insofar as the anticipation of a gradual greening of policy in the sense of an increasing cash flow or sufficiently increasing consumption tax rate will make the flow of current extraction even higher, and speed up global warming and natural resources' depletion even more, than would be the case without government intervention. Unfortunately, this result applies to the bulk of the green demand reducing policies (increasing tax rates, better insulation of homes, lighter cars,traffic reductions, the generation of electricity from wind, water, sunlight, biomass or vehicle brakes (hybrid cars), nuclear energy, pellet heating, bio diesel, heat pumps or solar heating, optimized power plants that increase the technical efficiency of combustion processes) [268].

As it appears in the Graph 5, the original equilibrium (with the green supply and red demand) occurs at the price of P1 and quantity (bought and sold) of Q1. As the demand curve moves (to the purple curve), the equilibrium price decreases to P2 and the quantity (bought and sold) decreases to Q2. Buyers buy less of the good, and pay a lower price to get it [269]. The Law of Supply and Demand is also applied herein leading to a Green Paradox. Although

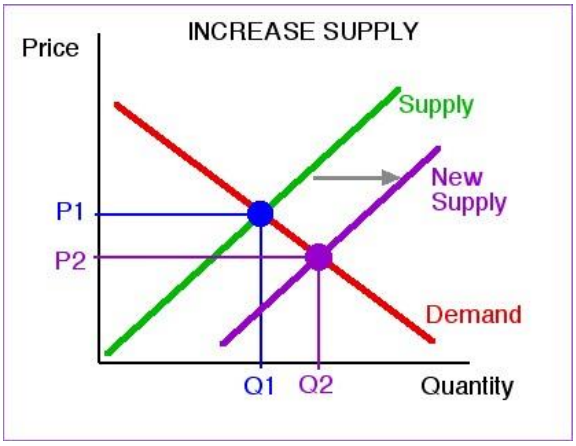
[264] (Branger & Quirion, 2014/02/01, pp. 53-71)
[265] (Sinn, 2007)
[266] (Sinn, 2007)
[267] (Sinn, 2007)
[268] (Sinn, 2007)
[269] (Bromley, 2007)



politicians try to reverse the Greenhouse effect by using green demand reducing policies, as decreasing demand by shifting the demand curve to the left leads to a decrease in price (**Graph 5)**, they end up incentivizing pollution.

Graph 5: Law of Supply & Demand - decrease in Demand leading to a price decrease
Source: Ray Bromley, 2007, pcecon.com Economics Notes and Study Aids, online http://www.raybromley.com/notes/equilchange.html

What's more, according to Sinn *"green policies, by heralding a gradual tightening of policy over the coming decades, exert a stronger downward pressure on future prices than on current ones, decreasing thus the rate of capital appreciation of the fossil fuel deposits"*. The owners of these resources regard this development with concern and react by increasing extraction volumes, converting the proceeds into investments in the capital markets, which



offer higher yields. Resource extractors by making the supply path steeper, exacerbate the problem of global warming[270]. As it appears in the Graph 6, the original equilibrium (with the green supply and red demand) occurs at the price of P1 and quantity (bought and sold) of Q1. As the Supply curve moves (to the purple curve), the equilibrium price decreases to P2 and the quantity (bought and sold) increases to Q2 Sellers sell more of the good, but get paid a lower price to sell it[271].

Graph 6: Law of Supply & Demand - decrease in Demand leading to a price decrease
Source: Ray Bromley, 2007, pcecon.com Economics Notes and Study Aids, online available at: http://www.raybromley.com/notes/equilchange.html

According to the *Law of Supply and Demand* also applied herein, due to lower resource prices, resource owners increase extraction by shifting the supply curve to the right and thus decreasing the price to a further lower level. Because of the increase in current supply, the current world market price declines so much that the extra demand of the nonparticipating in Kyoto Protocol countries overcompensates the demand restraint of the participating ones[272]. According to an OECD report, in OECD countries and key emerging economies government support to fossil fuel consumption and production is high, at USD 160-200 billion annually, even more hampering global efforts to curb emissions and combat climate change[273].As Sinn concluded *"markets unfortunately are unable to find the optimal path for*

270 (Sinn, 2007)
271 (Bromley, 2007)
272 (Sinn, 2007)
273 (OECD, 2015)

this double stock-adjustment problem. Insecure property rights of resource owners and the externality of global warming distort the private incentives, leading both to overextraction relative to the criterion of intertemporal Pareto optimality"[274].

While ad-valorem carbon taxes and other demand reducing measures of the type emphasized by politicians and in the public debate may be useless or even dangerous, because they may cause countervailing supply reactions, the set of effective policies against global warming is not empty. The remaining possibilities basically consist of public finance measures to flatten the supply path, safer property rights, binding quantity constraints and, technical means to decouple the accumulation of carbon dioxide from carbon consumption.The difficulty with the public finance solution to the problem of global warming is that it is of a static nature while the problem is intrinsically dynamic. This difficulty can be avoided by not speculating about the economy's quantity reactions to price signals but by controlling the quantities themselves. This can best be done with systems of emissions license trading such as those existing in the US and Europe, and it is the approach of the Kyoto Protocol. In principle it will work, because the aggregate extraction path itself is controlled by political decisions, while the market only has the task of allocating the necessary restraint in carbon consumption efficiently among firms and countries. With quantity constraints on CO2 production, the governments of the consumption countries effectively create a world-wide monopsony for carbon that cuts demand and depresses the producer price of carbon at the same time. As this creates a monopsony profit at the expense of the resource extracting countries and mitigates the problem of global warming in addition, there is every reason to participate. A complete world-wide system of emissions trading that effectively combines the consuming countries to a monopsony would be able to enforce a more conservative carbon consumption path while in addition providing these countries with monopsony rents. Where possible, a stabilization of property rights in the resource extracting countries could also be tried to strengthen the conservation motive.[275]

However, the Kyoto Protocol constrains only a minority of countries. The countries that ratified the Protocol and face binding constraints consumed just 29% of annual carbon supply in 2004. The countries constrained by the Kyoto Protocol included the EU–27 (which contributed 15% of world CO2 emissions), Canada (2%), Iceland (0.008%), Japan (4.6%), New Zealand (0.12%), Norway (0.14%), Russia (5.7%) and the Ukraine (1.1%). The USA contributed 21.8%, China 17.8%, Australia 1.3% and India 4.1% of world CO2 emissions in 2004[276]. India and China signed, but are not constrained, and many countries including the USA and Australia did not sign. Unless these countries participate, nothing is gained. As Sinn admits: "The efforts of the EU, which has promised in the Kyoto Protocol to reduce its production of carbon dioxide. (including carbon equivalents of other greenhouse gases) from 1990 to 2008–2012 by 8%, simply subsidize an even faster resource intensive growth process in China and make Americans drive even more SUVs and mega-trucks than they would have done anyway"[277]. Accoring to Sinn, the market failure is driven exactly by the incompleteness of the trading system. If it does not incorporate all important countries of the world, it may be useless or even counterproductive in the same sense as other demand reducing measures are. The trading system reduces the demand of the participating countries

[274] (Sinn, 2007)
[275] (Sinn, 2007)
[276] (IEA, 2006)
[277] (Sinn, 2007)

and hence depresses the world market price at which the non-participating countries can buy the carbon[278].

According to Sinn *"an effective climate policy must perforce focus on the hitherto neglected supply side of the carbon market in addition to the demand side. Useful policy measures that mitigate the problem of global warming must succeed in flattening the carbon supply path in the world energy markets"*[279]. The ways proposed as practicable by Sinn include levying a withholding tax on the capital gains on the financial investments of fossil fuel resource owners, or the establishment of a seamless global emissions trading system that would effectively put a cap on worldwide fossil fuel consumption, thereby achieving the desired reduction in carbon extraction rates.

B. Competitiveness Channel

The root of the competitiveness channel is that the cost of compliance gives a comparative disadvantage to regulated firms vis-à-vis their competitors. This change of relative prices can lead to a change of the trade balance (less exports and more imports). In the short term, this would correspond to a change of the utilisation rate of existing capacities ("*operational leakage"*), while in the long term, it would correspond to a change in production capacities ("*investment leakage*"). These changes induce a shift of production, and then of emissions, from the regulated part of the world to the unregulated one. Armington elasticities represent the substitutability between domestic and foreign products and can be used as indicators for carbon leakage through the competitiveness channel[280].

According to Branger and Quirion, the term of competitiveness refers to two forms of ability. As *"ability to sell"* it refers to the capacity to increase market share, and can be measured through indicators involving exports, imports and domestic sales while as *"ability to earn"*, it refers to the capacity to increase margins of profitability, and can be measured with indicators involving some measures of profit or stock values. As they explain in their research, distributing free emission allowances based on historic data only, increases the ability to earn but not the ability to sell, since an operator can close a plant and continue to receive the same amount of allowances. Hence, only competitiveness as ability to sell may generate leakage. However, the notion of competitiveness at the national level is controversial. Its main indicator is the balance of trade, i.e. the difference between the monetary value of exports and imports, but an increase in the balance of trade may result from many factors, some of which are completely unrelated to the competitiveness of domestic firms, like a contraction in domestic demand[281].

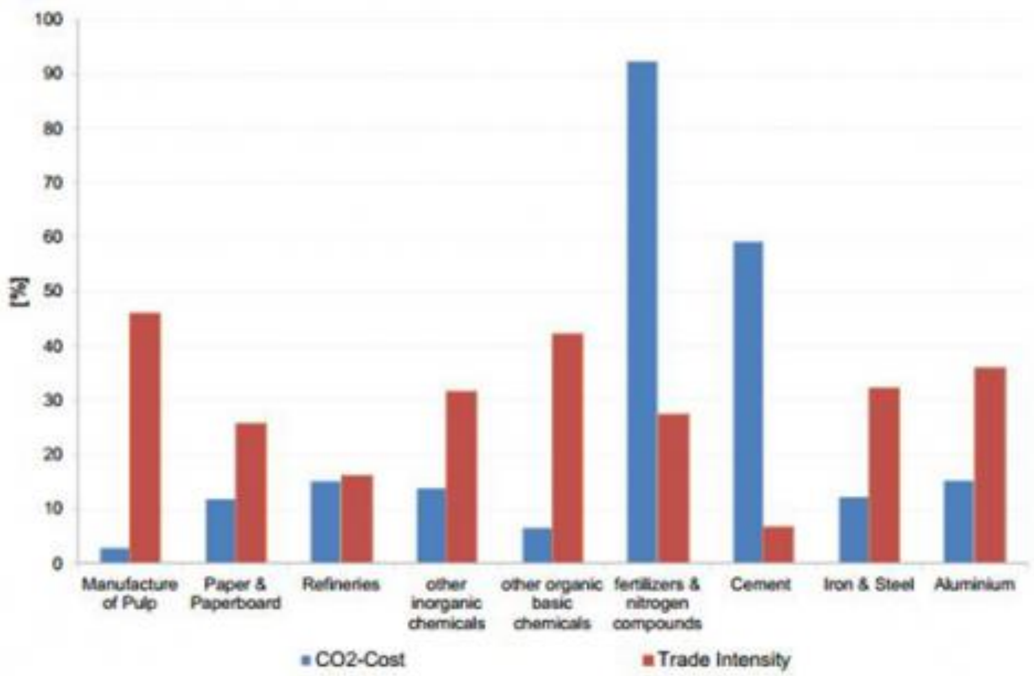
The risk of carbon leakage may be higher in certain energy-intensive industries**[282]**. In the EU-ETS context, carbon leakage is defined as an increase in emissions outside the EU as a result of the policy to cap emissions within the region[283]. To safeguard the competitiveness of industries covered by the EU ETS, the production from sectors and sub-sectors deemed to be exposed to a significant risk of carbon leakage, as included in an official list, receive a higher share of free allowances, compared to the other industrial installations. Freely

[278] (Sinn, 2007)
[279] (Sinn, 2007)
[280] (Branger & Quirion, 2014/02/01, pp. 53-71)
[281] (Branger & Quirion, 2014/02/01, pp. 53-71)
[282] (European Commission)
[283] (Reinaud , 2008)

allocating fewer than 15% of the emissions allowances generally suffices to prevent profit losses in the most vulnerable industries. Freely allocating all of the allowances substantially over-compensates these industries[284]. According to the ETS Directive[285], (Article 10a (15)), a sector or sub-sector is deemed to be exposed to a significant risk of carbon leakage if direct and indirect costs induced by the implementation of the directive would increase production cost, calculated as a proportion of the gross value added, by at least 5%; and the sector's trade intensity with non-EU countries (imports and exports) is above 10%. A sector or sub-sector is also deemed to be exposed (Article 10a (16)) if the sum of direct and indirect additional costs is at least 30%; or the non-EU trade intensity is above 30%.

The Commission is required to draw up a new list every five years. The first carbon leakage list was applied in 2013 (phase 3). The list was amended in 2011, 2012 and 2013. The second carbon leakage list, which applies for the years 2015-2019, was adopted in October 2014[286]. As it is indicated in the Figure 13 fertilizers and cement are the sectors in the biggest danger of carbon leakage.

Figure 13: Quantitative assessments of the main sectors exposed at risk of carbon leakage



Source: Marcu, A., Egenhofer, C., Roth, S., Stoefs,W. (2013). "Carbon Leakage: An overview", Centre of European Policy Studies (CEPS) Special Report No. 79, December 2013. Based on: Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, 5.6.2009, p.16-62, available at, https://climatepolicyinfohub.eu/carbon-leakage-and-industrial-innovation

Assessing the "true" impact of asymmetric carbon pricing will always be hampered by the compensation measures aimed at reducing competitiveness losses. Levelling down can be achieved through investment subsidies, sectoral exemptions or free allocation of permits, so as to decrease or even suppress the carbon cost for targeted sectors. The most vulnerable sectors, usually referred as the *Energy Intensive Trade Exposed (EITE)* ones, such as iron

[284] (Branger & Quirion, 2014/02/01, pp. 53-71)
[285] (EUROPEAN PARLIAMENT & EUROPEAN COUNCIL, 2003)
[286] (European Commission)

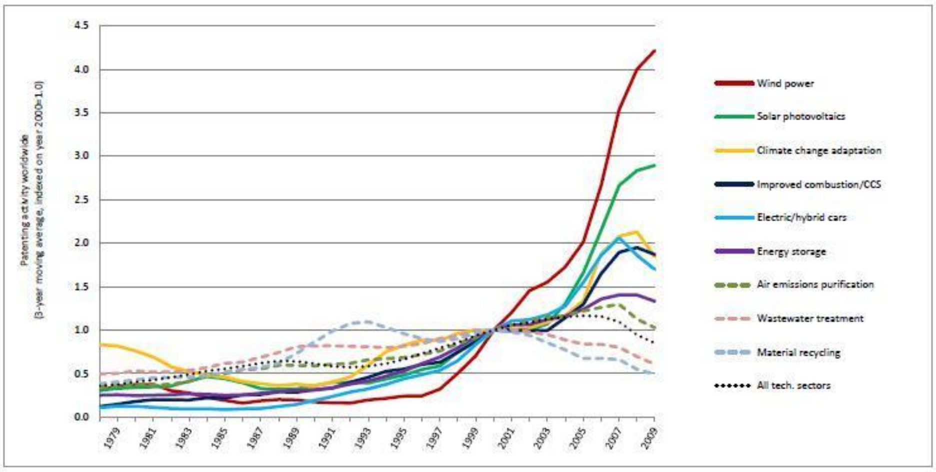
and steel, cement, refineries and aluminium, are well-organized and constitute a strong lobby that has managed so far to influence climate policies, so as to provide more favourable rules for them compared to others[287]. Effects of climate policies are always in practice compensated by "policy packages". Because of carbon leakage and competitiveness concerns, sectors at risk in the EU ETS received allocations free of charge while in every case of CO2 tax, they benefited from lower tax rates or exemptions. In addition, aluminium producers and other electricity-intensive industries, protected by long term electricity contracts, have not always suffered the pass-through of carbon costs to final consumers by electricity companies[288].

In the case of the EU ETS, the CO2 price has been below €14 for the majority of the time since the launch of the system, arguably too low a value to entail noticeable impacts. Instead of auctioning, three main options for allocating free allowances have been considered: historic, output-based and capacity-based allocation (used in the EU ETS). These free allocation methods induce side effects: in order to prevent competitiveness issues, other distributional and cost-effectiveness issues are created. In case of historic and capacity-based allocation the ability to pass-through carbon costs creates windfall profits for the operators of covered installations. Nevertheless, simulations indicate that output-based allocations seem more efficient to counteract leakage and protect industrial competitiveness while assuring political acceptability[289].

For each installation in the EU ETS, the amount of free allocation is calculated based on a formula where its production quantity (in tonnes of product) is multiplied with the the relevant product-specific benchmark value (measured in emissions per tonne of product). Installations in sectors exposed to a significant risk of carbon leakage in principle are eligible to receive free allocation at 100% of this quantity. For installations in other sectors, not on the carbon leakage list, the free allocation is gradually reduced across phase 3, as already mentioned, from 80% in 2013 to 30% in 2020. The benchmarks are defined starting from the average 10% of the most efficient installations, in terms of greenhouse gases, taking into account the techniques used, substitutes and alternative production processes. [290] As a result, only these ones in each sector receive enough free allowances to cover all their needs[291] (see also section IV5C). Moreover article 10a(6) of the revised ETS Directive gives Member States the possibility to compensate the most electro-intensive sectors for increases in electricity costs as a result of the EU ETS, through national state aid schemes for indirect emissions. The European Commission has published guidelines to ensure that such measures are in line with EU state aid rules. The Commission must approve the national schemes before any aid can be granted[292].

[287] (Branger & Quirion, 2014/02/01, pp. 53-71)
[288] (Branger & Quirion, 2014/02/01, pp. 53-71)
[289] (Branger & Quirion, 2014/02/01, pp. 53-71)
[290] (The European Association for the Promotion of Cogeneration (COGEN Europe) , 2011)
[291] (European Commission)
[292] (European Commission)

Figure 14: Innovation activity in low-carbon technologies, Compared to All Sectors



Source: OECD 2011. OECD Project on Environmental Policy and Technological Innovation, Based on data extracted from the EPO Worldwide Patent Statistical Database (PATSTAT), available at: http://www.oecd.org/env/consumption-innovation/innovation.htm

As part of the 2030 climate and energy policy framework, EU leaders decided to continue the free allocation of emission allowances until 2030. While the ETS Directive revision process is on-going, preparatory work has begun for the Carbon Leakage List that will be valid after 2020[293]. Overall, the risk of carbon leakage is estimated to be considerably lower than when the 2020 climate and energy package was adopted in 2009. Due to a repeated oversupply of allowances, initially due to lenient allocations on the national level, and from 2008 onwards due to the financial, economic crisis and subsequent decreased output, most industrial installations covered by the EU ETS have accumulated a significant surplus of free allowances, and the carbon price has declined significantly, reflecting the lower demand for allowances while providing only a limited incentive for emission reduction[294]. Therefore, a temporary withdrawal of a number of allowances (so-called *backloading*) has been agreed until 2019-2020, in order to increase demand. However, GHG emissions restrictions posed by the EU ETS have created competition between European and developing countries; the latter are not subject to such limitations. This situation can also result in further *carbon leakage*. In order to face this competitiveness issue, production from sectors and sub-sectors deemed to be exposed to a significant risk of carbon leakage received more free allowances in the third trading period between 2013 and 2020.[295]

On the other hand, putting a price on carbon emissions forms a way of creating incentives for the phasing out of polluting technologies and promoting a shift to low carbon alternatives. Industries are being motivated to transform their technology and improve their production process in order to reduce emissions and comply with regulations while at the same time they improve thrir competitiveness. Carbon leakage prevention measures thus aim to facilitate such innovation and provide sufficient incentives for research in breakthrough technologies, which is necessary for the achievement of radical changes in energy use and CO_2 emissions

[293] (European Commission)
[294] (European Commission)
[295] (climatepolicyinfohub.eu)

in the industrial sector[296]. According to the Organisation for Economic Co-operation and Development (OECD)[297] innovation activity in low-carbon technologies presented a dramatic growth rate during the period following the Kyoto Protocol agreement in 1997, as indicated in the above Figure 14. The stronger increase was observed in patents for wind and solar power.[298]

2. *Environmental Kuznets Curve (EKC) & Pollution Haven Hypothesis (PHH) – A cause and effect relationship*

In recent years, increased economic development, globalization, and liberalization of international trade have been linked by economists and environmental scholars as possible causes for specific trends in pollution. The possibility of a cause and effect relationship between the Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis (PHH) is gaining interest due to increasing environmental concerns over the last few decades. However, scientific research does not strongly support the theory, as there is very little evidence to suggest that an EKC as a consequence of PHH really exist. More refined empirical models and better data availability in the future may indicate why some countries experience an increase in dirty production[299].

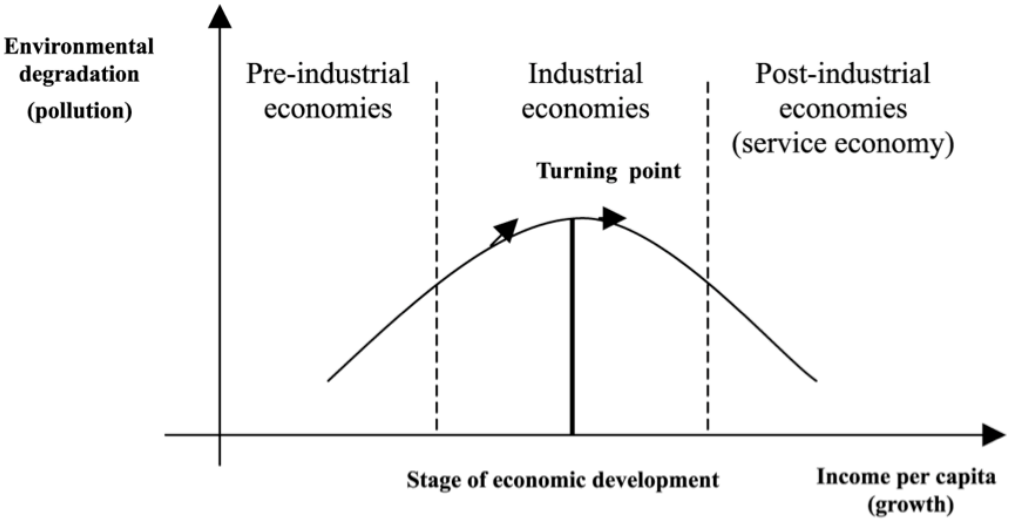
According to theory, globalization opens up the possibility of specialization in countries with comparative advantages in the world economy leading to economic growth due to the cost advantages of economies of scale. If a country’s government enforces stricter environmental regulations costing domestic industries more to produce their goods, those industries may relocate to less developed countries with lower regulation standards. It may be cheaper to produce identical goods in countries because they have a comparative advantage in the industry. Pollution Abatement Costs (PAC) have an impact on investment decisions and trade flows. As globalization and liberalization of trade allows countries to trade more freely from one country to another, some countries' industrial and manufacturing compositions are much more dynamic than they used to be. More specifically, more developed countries experience an increase in their imports from dirty industries and a respective fall in their exports, while developing countries’ exports from those industries increase[300]. Countries try to set their environmental standards below socially-efficient levels in order to attract investment or to promote their exports. One study found that environmental regulations have a strong negative effect on a country's Foreign Direct Investment (FDI), particularly in pollution-intensive industries while they have an insignificant impact on that country's trade flows[301].

Brian Jbara’s defined the EKC as *“a conceptual model that suggests that a country's pollution concentrations rise with development and industrialization up to a turning point, after which they fall again as the country uses its increased affluence to reduce pollution concentrations”* stating that the cleaner environment in developed countries comes at the expense of a dirtier environment in developing countries[302]. As one of the factors that may

[296] ((IEA), 2012)
[297] (Organisation for Economic Co-operation and Development (OECD), 2011)
[298] (climatepolicyinfohub.eu)
[299] (Jbara , 2007)
[300] (Jbara , 2007)
[301] (Millimet, 2013)
[302] (Jbara , 2007)

drive the increase in environmental degradation seen in pre-industrial economies is an influx of waste from post-industrial economies, the EKC is potentially a reflection of the PHH. This same transfer of polluting firms through trade and Foreign Direct Investments (FDIs) could lead to the decrease in environmental degradation seen in the downward-sloping section of the EKC, which models post-industrial (service) economies[303]. As it is indicated in Graph 7, plotting pollution concentrations against income per capita yield an inverted U curve. This is because, after a certain level of development, countries' pollution concentrations begin to decrease as GDP per capita continues to increase[304].

Graph 7: The Environmental Kuznets Curve (EKC)



Source: Verdinand Robertua, 10th December 2015, Environmental Kuznets Curve, available at: https://jfkoes.files.wordpress.com/2012/06/ekc.png

A related issue is the manner in which the more developed or affluent countries reduce their pollution concentrations. That is, assuming that the EKC hypothesis is correct, there are two main theories about how developed countries clean up their environments. According to Brian Jbara's research one is that countries after a certain level of development become more concerned about the environment and adopt cleaner and more environment-friendly technologies to produce their goods. It suggests that at some point in the future all countries may be on the downward sloping side of the EKC, and that increasing development implies a cleaner global environment. The other less hopeful possibility is that developed countries simply specialize more and more in the production of products of cleaner industries and import the products of dirty industries from developing countries while the less affluent or developing countries take over production of products from dirtier industries. Dirty production shifts there in fact from developed countries. This suggests that the cleaner environment in developed countries comes at the expense of a dirtier environment in developing countries, which are therefore considered as *"pollution havens"*. This is the essence of the *Pollution Haven Hypothesis (PHH)*[305].

According to the PHH, stringent environmental regulations and economic activity are negatively correlated, because regulations raise the cost of key inputs to goods with pollution-intensive productions reducing relevant countries' comparative advantage in these goods. This lack of comparative advantage causes firms to move to countries with lower

[303] (Moseley, et al., 2014)
[304] (Jbara , 2007)
[305] (Jbara , 2007)

environmental standards, decreasing economic activity. These differences in environmental regulations between developed and developing countries may be compounding this general shift away from manufacturing in the developed world and causing developing countries to specialize in the most pollution intensive manufacturing sectors. In the developed world the cost of meeting environmental regulations appears to be increasing regularly over time. Since such costs are undoubtedly far lower in most developing countries it is possible that developing countries may possess a comparative advantage in pollution-intensive production. The PHH therefore provides further ammunition to those who claim that the EKC's inverted U-shape is simply caused by the developed countries exporting their pollution to the developing world.The PHH claims that differences in the stringency of environmental regulations between the North and the South will provide the latter with a comparative advantage in pollution intensive production. The North may therefore increasingly specialize in clean production and rely on the South for the provision of pollution intensive output. If the PHH holds, then the EKC may not imply a net reduction in pollution, but simply a transfer of pollution from North to South[306]. On the other hand, if the PHH does not exist, it implies that dirty industry production is not just trading places among countries, but could be decreasing overall. If the EKC does exist, we can only be hopeful that it is because countries are adopting cleaner technology and not by the occurrence of pollution havens[307].

Gene M. Grossman and Alan B. Krueger in their study, one of the most important foundational studies for the EKC, found evidence that indeed economic growth brings an initial phase of deterioration in environmental quality up to a certain level followed by a subsequent phase of improvement. They also investigated the *"peak turning points"* of the inverted U relationship between income per capita and pollution for the different pollutants, and found that the peak level of pollution in most cases occurs at an early point in a country's economic development and more specifically before a country reaches a per capita income of $8000.The main reason according to them is that citizens in countries with high incomes insist that government policy pay more attention to aesthetic factors such as a cleaner environment. In this way, policy in high income countries enforces stricter environmental regulations which help to keep the environment clean[308]. Jeffrey A. Frankel and Andrew K. Rose in their research observed an apparent positive correlation between trade openness and some measures of environmental quality. Although, as they admitted, this could be due to endogeneity of trade, rather than causality, their results generally supported the EKC, proving that growth harms the environment at low levels of income and contributes to its improvement at high levels while trade openness accelerates the growth process[309].

A useful reference on the PHH is M. Scott Taylor's study. Taylor discussed the theory behind the PHH by linking a country's characteristics to predictions of trade flows of dirty production. He investigated theoretical and empirical models that try to explain the PHH. One model identified two main factions in the trade of dirty industries: *North* and *South*. The *North* refers to developed countries whilst the *South* refers to developing countries. According to Taylor, the pollution levels in each faction are a result of the composition of trade between the two. He argued that *"the North becomes cleaner at the expense of the South, as it ships there its dirty industries and that trade alters the composition of output in both North and South because of differences in the stringency of their pollution regulation"*.

[306] (Cole, 2004, pp. 71-81)
[307] (Jbara , 2007)
[308] (Grossman & Krueger, 1995, pp. 353-377)
[309] (Frankel & Andrew , 2005, pp. 85-91)

According to his analysis dirty goods are relatively expensive in the tight regulation *North* and relatively cheap in the lax regulation South and regulation levels are functions of the endogenous *North-South* income gap. Given the relative cost structure, a movement to free trade shifts dirty good production to the South increasing their economic growth and clean good production to the *North*, where clean environment is set as a priority. Pollution falls in the *North* because the composition of its industries becomes cleaner with trade while it rises in the *South* because the composition of its industries becomes dirtier with trade. Finaly, his study validates the fact that world pollution rises with trade because the world's dirtiest industries locate in the country with the lowest environmental standards[310]. Furthermore, Beata Smarzynska and Shang-Jin Wei in their study attempted to find evidence that multinational firms, particularly heavily polluting ones, are in fact relocating to environments with less stringent regulations. They concluded that investment from pollution – intensive multinational firms as a share of total inward FDIs is lower for host countries with a higher environmental standard[311].

Jean-Marie Grether and Jaime de Melo in their study provided evidence on the impact of globalization on the environment, examining the international trade flows of five heavily-polluting industries for 52 countries over the period 1980-98, that might indicate pollution havens. Overall, they found some evidence, since four out of the five polluting industries they measure moved from developed to developing countries in this period. According to their analysis, concerns that polluting industries would *"go South"* was first raised in the late eighties at the time when labor intensive activities like the garment industries were moving South in response to falling barriers to trade worldwide. Such delocalization could be characterized as a continuous search for *"low-wage havens"* by apparel manufacturers in an industry that has remained labor-intensive. Fears about pollution havens were already expressed at the time notably because of the possible impact of the regulatory gap between OECD economies where polluters paying more would lead them to search for *'pollution havens'* analogous to *'low-wage havens'*. Later with the globalization debate, the hypothesis gained new momentum by those who have read into globalization a breakdown of national borders, making it difficult to control location choices by multinationals. A new decomposition of Revealed Comparative Advantage (RCA) according to geographical origin revealed a delocalization to the South for all heavily-polluting industries except non-ferrous metals, which exhibits South- North delocalization in accordance with factor-abundance driven response to a reduction in trade barriers. Panel estimation of a gravity model of bilateral trade on the same dataset revealed that, on average**,** polluting industries have higher barriers-to-trade costs (except non-ferrous metals with significantly lower barriers to trade) and little evidence of delocalization in response to a North-South regulatory gap[312].

Matthew Cole's study combined the EKC theory with the PHH, by suggesting that trade in dirty industries may explain why developed countries pollution levels fall over time. He examined the extent to which structural change and trade openness and specifically the migration or displacement of 'dirty' industries from the developed regions to the developing regions, the PHH, has contributed to the EKC relationship. The share of pollution intensive imports and exports, between OECD and non-OECD countries, appears to at least partially explain emissions and indicators of environmental quality. The air pollution emissions appear to have experienced an inverse relationship with the share of pollution intensive imports from developing countries. The EKC analysis the share of manufacturing output in

[310] (Taylor, 2004)
[311] (Smarzynska & Shang-Jin , 2001)
[312] (Grether & De Melo, 2003)

GDP generally has a positive, statistically significant relationship with pollution. Thus, the relative contraction of the manufacturing sector as a whole has proved beneficial to OECD pollution emissions. Finally, having controlled for structural change, income and possible pollution haven effects, trade openness still exhibits a negative, statistically significant relationship with pollution. To be somewhat speculative, this may be due to resource efficiencies arising from increased competitiveness or from greater access to 'greener' production technologies. The downturn in emissions experienced at higher income levels therefore appears to be a result of the increased demand for environmental regulations and increased investment in abatement technologies (both facilitated by higher income levels), trade openness, structural change in the form of a declining share of manufacturing output, and increased imports of pollution intensive output. It is unclear whether today's Least Developed Countries LDCs can expect to experience a decline in manufacturing as a share of GDP, and hence can experience similar pollution-income paths to today's developed economies. If the income elasticity of demand for manufactured products does not fall as income increases, then the declining manufacturing share of GDP simply reflects the fact that the developed countries' demand is now being met by the developing countries. The developing countries will therefore have no one to whom this production can be passed[313].

The growing literature on the topic of trade and the environment has suggested a large number of potential interactions between trade liberalization and pollution. Mixed evidence are provided and hence it is difficult to claim that the displacement and migration of developed country dirty industries are reducing pollution overall. It has been claimed, for instance, that trade openness may, ceteris paribus, reduce pollution emissions as countries facing greater competitive pressure may become more efficient in resource use. As Matthew Cole argued: *"trade openness per se appears to facilitate environmental improvement perhaps through increasing competitiveness and the efficiency of resource use. This may be due to technological advances that increase the efficiency, and reduce the cost, of abatement or due to increasing awareness of pollution issues leading to increased demand for environmental regulations"*[314].

Precisely, how the composition effect affects pollution depends on a country's sources of comparative advantage and specifically on whether it has a comparative advantage in pollution intensive production. As the industrial economies have developed there has been a change of emphasis from heavy industry towards light manufacturing and services. In contrast, the developing countries have increased their specialism in the heavy industrial sectors. As Stern has claimed *"these structural changes may reflect the South's specialization in the production of goods that are intensive in natural resources and labor, in line with the Hecksher–Ohlin theory"*. If this has led to a general shift of manufacturing activity from North to South, then he speculates that this may have at least partly contributed to the EKC inverted U relationship[315]. For Alan Krueger and Gene Grossman if so, then the EKC does not indicate that growth provides a *'cure'* for environmental problems but simply that as incomes increase, the developed economies export their manufacturing industries[316].

Levinson &Taylor in their research using data on U.S. regulations and trade with Canada and Mexico for 130 manufacturing industries from 1977 to 1986, concluded that industries whose regulatory stringency pollution abatement costs (PAC) increased most, experienced

[313] (Cole, 2004, pp. 71-81)
[314] (Cole, 2004, pp. 71-81)
[315] (Stern, 1998)
[316] (Krueger & Grossman, 1991)

the largest relative increases in net imports representing a considerable fraction of the increase in total trade volumes over the period. More specifically they found that for the average industry, the change in net imports was amounting to 10% of the total increase in trade volume over the period[317]. However recent research on the effects of environmental regulations on trade flows has generated mixed results. Grossman and Krueger's original study of the North American Free Trade Agreement (NAFTA) found a negative and significant correlation between PAC and net imports[318]. This negative correlation can easily bias estimates against finding a pollution haven effect. According to their data, the United States tends to import from Mexico (a developing country with presumably lax regulation) those goods that face low pollution costs at home, and to import from Canada (a developed country with ostensibly tight regulation) those goods that face high costs, exactly opposite to the pollution haven hypothesis. Most likely, these correlations reflect the fact that Canada has an unobserved comparative advantage in natural resource industries that are relatively pollution intensive, whereas Mexico has an unobserved comparative advantage in laborintensive and relatively clean industries. Explanations of the limited evidence of the relocation of firms include the dependence of heavy industries on home markets, as low regulation countries may have certain characteristics which deter inward investment such as corruption, poor infrastructure and uncertain or unreliable legislation and as foreign investors may be concerned about their international reputation and do not wish to be perceived to be taking advantage of slack environmental regulations[319]. In addition, massive environmental relocations in case of stringent policies announced by EITE sectors' trade associations are not realistic: because these industries are very capital-intensive, they are less prone to relocation in general compared to *"footloose"* industries[320]. Moreover, it was argued that other motives for trade, in particular capital abundance, more than offset the effect of pollution regulations, leading developed countries to have a comparative advantage in many dirty-good industries[321]. This uncertainty is unfortunate because without firm evidence linking environmental control costs to trade flows, it is difficult to know whether governments have the ability, let alone the motivation, to substitute environmental policy for trade policy. Overall many countries may have undercut international tariff agreements by weakening environmental regulations to placate domestic protectionist interests[322].

The common point of all the studies is the assertion that environmental pressure increases faster than income at early stages of development and slows down relative to GDP growth at higher income level. Explanations for this EKC are seen in (i) the progress of economic development, from clean agrarian economy to polluting industrial economy to clean service economy; (ii) tendency of people with higher income having higher preference for environmental quality, etc. But, as Robertua Verdinand wondered in his aricle, which will be the progress of this situation, when all developing countries transformed to developed countries? [323]. In a finite world this then implies that today's developing countries will have no one to whom their manufacturing industries can be passed. They are therefore unlikely to be able to follow the same pollution income path as today's developed economies.

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317 (Levinson & Taylor, 2008)
318 (Krueger & Grossman, 1991)
319 (Neumayer, 2001)
320 (Ederington, et al., 2003)
321 (ANTWEILER, et al., 2001)
322 (Levinson & Taylor, 2008)
323 (Verdinand, 2015)

The reality for the foreseeable future is that climate policies will remain sub-global. In a world with uneven climate policies, the carbon price differentials across regions could shift the production of energy-intensive goods from carbon-constrained countries to *"carbon havens"*, or countries with laxer climate policy. This would reduce the environmental benefits of the policy (carbon leakage) while potentially damaging the economy (competitiveness concerns). Different mitigation targets among countries are legitimate under the *Principle of Common but Differentiated Responsibilities,* but too uneven climate policies are less efficient if they cause carbon leakage and are unlikely to survive the national policy-making process if they entail significant competitiveness losses. These concerns are among the main arguments against the implementation of stringent climate policies in industrialized countries. However, according to Branger & Quirion's assertion the induced diffusion of climate-friendly innovations generates abatement even in regions without climate policies, which may well compensate for leakage. Thus, leakage is clearly not a convincing argument against climate policies, although it invites actions to complement carbon pricing with specific measures in order to maximize their efficiency[324].

Right now, developing countries are exploiting their resources and degrading their environment. In their desire to develop and improve the standards of living of their citizens, these countries will opt for the goals of economic growth and cheap energy for all. This may lead to environmental pollution and degradation. More so, energy access, and at a lower price, is necessary to make the industries in developing countries competitive and contribute to economic growth, job creation and development. On the other hand, developed countries have achieved substantial economic growth and development through the overexploitation of their environment in the past and now can afford to focus on environmental goals because basic living necessities have been achieved. The greatest environmental injustice is between the developed and the developing world. Ultimately we are all interdependent, we share the same limited planet and the actions of one will matter to others. But consumption, greenhouse gases and waster have all increased – mainly because of the behavior of those from rich countries. And of course the result of this affects those in the countries with the least. Environmental justice is a matter of taking steps to ensure that the rich and powerful do not insulate themselves from environmental harm largely by displacing problems on the poor ad weak. The *Principle of Common but Differentiated Responsibilities* of states has been invoked as a matter of environmental equity and of fair distribution of power, wealth and opportunity. The Montreal Protocol adopted in 1987 successfully applied the principle of equity as a matter of common but differentiated responsibilities, especially after its London amendment in 1990, by assigning more responsibility to the developed countries for causing the ozone depletion problem, allowing developing countries a delayed schedule to phase out their carbon consumption and by establishing a funding and technology transfer mechanism for developing countries' transition to low-carbon substitutes. Based on environmental justice, developing countries are allowed to increase their carbon production but need to think to transform to cleaner technologies. EKC and environmental justice works together and the case study of Montreal protocol is a clear case for them[325].

3. *Emissions Trading Scheme (ETS) Paradox*

Doubts remain as to whether carbon finance can deliver tangible emissions reductions. Emissions trading schemes are related to some potential failures which should be taken into

[324] (Branger & Quirion, 2014/02/01, pp. 53-71)
[325] (Verdinand, 2015)

account. Strategic behaviour of some market players may harm other players who are directly or only indirectly related to emissions trading. Strategic behaviour is possible when some market players have significant or even monopolistic power in the emissions trading market. Information asymmetry can further increase the consequences of an unbalanced power situation. Banking can be used to enhance a company's or an industry's strategic situation, especially when allowances are mainly banked to influence current and future allowance's market prices. Allocating allowances due to the grandfathering principles creates windfall profits for companies with high numbers of allowances and a modern technology mix[326].

Emissions trading as originally described as a MBI to efficiently reduce GHG emissions. In the long run, it will lead to the deployment of more efficient technologies and to an increased availability of renewable energy. This judgement is based on the assumption of a perfect market and rational behaviour by all market players. This assumption does not hold in practice and leads to serious market failures described by Hagem and Westkog as the *Emissions Trading Paradox*. From an economic standpoint, banking should make emissions trading even more efficient, e.g. abatement costs cannot only be minimized during the course of a single year, but also, in a more dynamic approach, in a time period of several years. However, in terms of information asymmetry, when accurate emissions data are not publicly available, banking offers the opportunity to hide the actual level of emissions without wasting the allowances. This could lead to strategic behaviour, harmful to competitors or customers. This potential disadvantage is particularly relevant, as markets are imperfect[327].

More specifically, Eshel showed in a rigorous analysis that combined market power with information asymmetry can lead to social welfare losses if the allocation of pollution rights will allocate allowances to dominant firms (firms with a high amount of market power) too generously[328]. Due to lobbyism, this is exactly what happened in the subperiod 2005–2007. According to James Kanter, one reason was the over-allocation of allowances to enterprises in emission-intensive industries according to the grandfathering principle, which fueled volatility and helped some traders reap fatter-than-expected profits. [329] Mathew Carr and Saijel Kishan in their research argued that this was sometimes perceived as a protectionist obstacle to new entrants into market. There have also been accusations of power generators getting a windfall profit by passing on these emissions charges to their customers[330]. In addition, Florian Jaehn & Peter Letmathe in their article consider the price history of CO2 allowances in the first period EU ETS as a paradox, impossible to be forecasted by any model. Since it started in 2005, the prices of allowances have varied between less than one (1) and thirty (30) euro per ton of CO2. After a steep increase, the allowances seemed to be so scarce that their price per ton peaked at 30 euro in April 2006 and fell to a level of a few cents by the end of the trading period in December 2007. However, they showed that by taking into account some peculiarities of the market for allowances the price crash and its rationality could be explained[331].

Emissions trading is highly relevant for decisions on the firm level. In the short term, it might have influenced both the firms' product mix and the use of different installations. Pricing decisions were also affected, as companies could pass the costs of allowances to

[326] (Letmathe & Jaehn, 2010)
[327] (Hagem & Westkog, 2008)
[328] (Eshel, 2005)
[329] (Kanter, 2007)
[330] (Carr & Kishan, 2006)
[331] (Letmathe & Jaehn, 2010)

customers[332]. Strongly favouring some large enterprises with significant market power during the allocation of allowances according to the grandfathering principle made it possible for energy-producing companies to raise their product price in accordance with the high price of allowances, while at the same time no relevant costs occurred to them. Using empirical data Letmathe & Jaehn showed that emissions trading created opportunities for additional profits at the interest of energy-producing companies but at the expense of smaller emitters (more downstream industries) and private consumers, who were in a worse position due to higher energy costs. This effect was intensified further, as banking was allowed[333] [334].

According to Jaehn & Letmathe' s assumptions, this previously unpredicted volatility and, more notably, a significant price crash in May 2005 led to the hypothesis that electricity producers might have used their market power to influence the prices of allowances. For them, besides market power, the combination of structural factors like information asymmetry (as the large companies have better information of the total scarcity of allowances) and price interdependencies (between prices of primary goods – especially electricity – and allowances) played an important role in explaining the emissions trading paradox. Speculators' arguments that the peak level of allowance prices was purely the result of unexpected occurrences (e.g. weather turbulences) while their sharp fall was due to unexpected technological progress, which reduced the emission abatement costs and therefore led to extremely low allowance prices, are rejected in their research as unrealistic ones due to the oligopolistic nature of electricity markets, the existence of European wide models for optimization of carbon dioxide emissions[335] and to the long time needed for new technologies to be embedded[336], respectively. Furthermore, electricity-producing companies had a rational interest in hoarding and forfeiting allowances instead of selling them. Banking allowed within a trading period (i.e. allowances are valid in every year of the trading period but not in a different trading period) was proved profitable for sellers, who were acting rationally at the cost of buyers leading to such a price crash[337]. Even countries like Russia, a large supplier of natural gas, might use market power in the emissions trading market to influence gas prices to its own advantage. Since gas has a relatively low CO2 emission coefficient, high allowance prices could be favourable to boost demand for natural gas. Though only a small impact on the optimal level of Russian gas exports is found, findings clearly support the connection between market power and interdependent demand of CO2 allowances and natural gas[338].

What were the lessons from the first trading period? First of all, information asymmetry would be minimized through regular reporting of actual emissions levels. Annual reporting would not seem to be appropriate since inter-seasonal issues (such as weather occurrences and economic developments) made it difficult to forecast if surplus allowances were available. However, transparency alone wouln't be sufficient if market power was unbalanced. Then, limitations to banking allowances and enforcement of selling surplus allowances by restricting the validity of allowances to a shorter time period, say one year, would be appropriate to prevent the negative side effects of market failures. Lastly, auctioning instead of allocating allowances according to the grandfathering principle would

332 (Letmathe & Jaehn, 2010)
333 (Letmathe & Jaehn, 2010)
334 (Bode, 2006)
335 (Fichtner, 2005)
336 (Barreto & Kypreos, 2004)
337 (Letmathe & Jaehn, 2010)
338 (Hagem, et al., 2006)

reduce windfall profits in the electricity sector. In summary, market failures related to emissions trading could only be moderated though regulatory interventions into free emissions trade[339]. In compliance with that argument, Hagem and Westkog suggested interventions through adjusting allocations if single agents exercise their market power[340]. As the EU ETS moved into its second phase and joined up with Kyoto, it seemed that these problems would be reduced as more allowances would be auctioned[341].

4. *The Polluter - Pays Principle*

As it is already mentioned, in ETSs allowances can either be auctioned or distributed to the enterprises free of charge according to the prinsciple of grandfathering. Although grandfathering is frequently used, there is a popular view in the economic and legal literature that it is inconsistent with the *Polluter-Pays Principle*. As it arises from further research, the question of whether polluters pay under grandfathering or not depends on how the polluter-pays principle is interpreted, in terms of efficiency and distributive justice.

The *Polluter-Pays Principle* first appeared in 1972 in the Recommendation of the OECD Council on Guiding Principles concerning International Economic Aspects of Environmental Policies[342]. It basically means that polluters should pay for pollution prevention and control measures as well as for the environmental damage they cause and that the government should not subsidize pollution. Although the OECD document itself is not a binding international law, the polluter-pays principle can now be found in an increasing number of international treaties and instruments. The European Community (EC) formally adopted the principle in the 1987 Single European Act[343]. Since then, it is referred in in the paragraph 2 of article 174 of the EC Treaty and of the article 191 of the TFEU, as follows: *"Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It 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"* [344]. In this legal document, the principle is mentioned but not defined. A precise and generally accepted legal definition of the polluter-pays principle is lacking. In this context, Bugge distinguished between two different notions of the *Polluter-Pays Principle*, on the one hand, as an *"economic principle"* or *"a principle of efficiency"*, and on the other hand, as a *"legal principle of (just) distribution of costs"*[345]. According to Edwin Woerdman's, Alessandra Arcuri's and Stefano Clò's point of view, the efficiency interpretation reflects the idea that pollution costs should be internalized with the aim of achieving an efficient allocation of resources, irrespective of distributive issues, while equity is considered to be a notion of a fair distribution of costs. They also framed the equity criterion as an extension of the basic form of the principle, considering the efficiency interpretation to be its core included in the equity dimension[346].

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[339] (Letmathe & Jaehn, 2010)
[340] (Hagem & Westkog, 2008)
[341] (Carr & Kishan, 2006)
[342] (OECD, 1975)
[343] (COMMISSION, 1987)
[344] Consolidated version of the Treaty on the Functioning of the European Union - Part Three: Union Policies and Internal Actions - Title Xx: Environment - Article 191 (2) (ex Article 174 (2) TEC, *O.J.115 , 09/05/2008, P.0132–0133, available at:* *https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12008E191:EN:HTML*
[345] (Bugge, 1996)
[346] (Woerdman, et al., 2007)

As far as the efficiency dimension of this specific principle is concerned, Jonathan Remy Nash, building upon Wirth[347], in the context of his study on its potential conflict with tradable allowances, devised a further distinction distinguishing between (i) *a weak form* (no subsidization) and (ii) *a strong form* (cost internalization) of this normative doctrine. According to his assumptions, its weak form prohibits governmental subsidies for pollution control equipment to ensure that product prices reflect the costs of pollution abatement while the strong form calls for governments to assure the internalization of environmental costs (and not just to refrain from subsidizing pollution control equipment). Moreover, Nash insisted on the inconsistency of grandfathering with the *Polluter Pays Principle*'s core, violating even the principle's weak form. As he stated: *"the core of the polluter pays principle argues that neither the government nor society-at-large should subsidize pollution and polluters and that polluters should internalize the costs of pollution abatement"*[348]. Nash in order to support his claim argued that grandfathering as a governmental act subsidizes polluters, who are at liberty to sell the allowances, they received at no cost, on the market for cash payments, shielding existing, less efficient, market participants from new competition and incentivize them in an artificial and distortionary way not to exit the industry[349].

Contrary to Nash's views, Edwin Woerdman, Alessandra Arcuri and Stefano Clò, in their research demonstrated the consistency of grandfathering with both forms of the efficiency interpretation of the *Polluter-Pays Principle* taking a closer look at the nature of the subsidy that is inherent to grandfathering. Firstly, they emphasized the economic impact of the grandfathered allowances' opportunity cost. Precisely, they noted the fact that the firms instead of using these allowances to cover their emissions, they could have sold them and that this opportunity cost, equal to the allowance price, had to be included in the product price. As a result, the costs of pollution are internalized, which makes grandfathering consistent with the strong form of the polluter-pays principle ('cost internalization'). Secondly, because of the weak form's ('no subsidization') subsumption under the strong form (as both versions of efficiency interpretation require that companies internalize pollution costs) and of the nature of the grandfathered allowances as lump sum subsidies that do not distort competition, they assumed full compatibility of grandfathering with the efficiency interpretation of *Polluter-Pays Principle*[350].

However, according to their assumption, the claim that polluters do not pay under grandfathering could be defended from an equity perspective, based on an 'extended' form of the polluter-pays principle, as a criterion on top of (and not instead of) efficiency. Grandfathering improves the financial position of the shareholders, because polluters receive an asset with a market value for free. As a result they argued that even if the polluting firms pay under grandfathering because of the opportunity costs faced, they receive a capital gift equal to the revenues that the government would have obtained in an auction. Such a capital gift, while not distortive in efficiency terms, does have a redistributive impact which is beneficial for the polluter. Because polluting firms do not have to purchase the emission rights while their shareholders become richer, grandfathering may be perceived as unfair from an extended polluter-pays perspective[351].

[347] (Wirth, 1995)
[348] (Nash, 2000, p. 3)
[349] (Nash, 2000, pp. 13,24)
[350] (Woerdman, et al., 2007)
[351] (Woerdman, et al., 2007)

On the other hand, they concluded that auctioning is consistent with the extended form of the *Polluter Pays Principle*, by ensuring not only that pollution costs are internalized (efficiency), but also that producers purchase their emission rights before they pass on those costs to consumers (equity). Nevertheless, through their research it seemed to be more acceptable to consumers while grandfathering could make a stringent cap-and-trade scheme acceptable to producers[352]. Therefore, politicians may still have good reason to prefer grandfathering[353].

5. *Regulatory Capture*

Regulatory Capture is an economic theory describing that regulatory agencies may come to be dominated by the industries or interests they are charged with regulating. As a result of this form of government failure, the agency, which is charged with acting in the public's interest, instead acts in ways that benefit the industry it is supposed to be regulating. Regulatory capture, also known as the economic theory of regulation, became known in the 1970s due the late George Stigler, a Nobel laureate economist at the University of Chicago, who first defined the term. Stigler noted that regulated industries maintain a keen and immediate interest in influencing regulators, whereas ordinary citizens are less motivated[354]. Thus even though the rules in question, such as pollution standards, often affect citizens in the aggregate, individuals are unlikely to lobby regulators to the degree of regulated industries. Moreover, regulated industries devote large budgets to influencing regulators at federal, state and local levels. By contrast, individual citizens or groups of them, even the well-organized ones, have only limited resources relative to industry interests at heir disposal to spend, so as to advocate for their rights[355].

Regulatory agencies that come to be controlled by the industries they are charged with regulating are known as captured agencies. Eventually a captured public-interest agency operates essentially as an advocate for the industries they regulate. Such cases may not directly corrupt as there is no quid pro quo; rather, the regulators simply begin thinking like the industries they regulate, due to heavy lobbying. In many cases the regulators themselves come from the pool of industry experts and employees, who then return to work in the industry after their government service. This is a version of the system known as the *"revolving door"* between public and private interests. In some cases, industry leaders trade the promise of future jobs for regulatory consideration, making revolving doors criminally corrupt[356].

As it is emphasized, the design of the EU ETS appeared to demonstrate regulatory capture by the carbon-intensive industries. Theoretical and some empirical work suggested that the excessive level of free allocation that has been historically provided by the EC to firms according to the prinsciple of grandfathering has been extremely generous whereas profit neutral allocations required only a minority of allowances to be freely allocated, even in trade –exposed sectors. Decision making at the level of the EC remains slow, involving a large number of veto players and *Regulatory Capture* through lobbying[357]. In addition, due to a consolidated rent-seeking behavior each individual polluter wants to be a seller rather

352 (Baumol & Oates, 1988)
353 (Woerdman, et al., 2007)
354 (Stigler, 1971)
355 (Kenton, 2018)
356 (Kenton, 2018)
357 (Parry, et al., 2017)

than a buyer of allowances. As a result, through grandfathering firms may also be incentivized to pollute in order to obtain more allowances. Although this can be prevented by choosing a historical base year that polluters cannot influence, companies will try to lobby in favor of a different or updated base year if this provides them with more allowances[358].

When regulatory capture occurs, the interests of firms or political groups are prioritized over the interests of the public, leading to a net loss for society. However, some economists discount the significance of *Regulatory Capture* as a market failure pointing out that many large industries which lobby regulators, such as industries in the fossil fuel sector, have experienced lower profits due to regulation after having failed to capture agencies[359].

[358] (Egenhofer & Fujiwara, 2005)
[359] (Kenton, 2018)

VI. EU ETS & Game Theory

Lacking a world government, the world is an anarchic community of some 200 sovereign nation-states that strive to survive[360]. Wars and conflict erupt as a result of this international anarchy[361]. It is the very organization of international relations (IR) rather than the nature of man that determines war. In response to the international anarchy, states realize that their dominant strategy externally is to try to secure their survival by increasing their power; internally, they can afford to focus on quality of life for their citizens[362] [363].

Game theory is a mathematical tool for analyzing situations where two or more subjects make decisions that will affect mutual benefit or damage. It is defined as 'a scientific discipline which describes different situations of conflict and finds suitable models for their resolution. It uses general mathematical techniques for analyzing situations in which two or more subjects make decisions that will affect both sides'. Founders of the modern game theory are considered to be John von Neumann and Oscar Morgenstern[364]. It is applied in many sciences as an auxiliary tool: 'In economy, where it is mostly used in modelling of the behavior of competitors in the oligopolistic market and in other market relations characterized by a small number of players, in the area of international relations and geopolitics (international cartels, extraction of common resources, coalitions, and international negotiations) and others'[365]. Basic components of game theory are players, strategies, moves, and a presumption of rationality of each player, according to whom every player makes a choice aiming to maximize his utility i.e. to obtain the maximum gain with minimum costs and efforts[366].

Theory examines decision problems where two or more agents (called *players*) choose between alternative strategies in order to maximize their payoff—this is called rational behavior. Such problems are called strategic games, they can be of simultaneous or sequential movement and they highlight the interactive interdependence of players that together determine the final outcome. Games are solved when players reach a point of balance, an equilibrium. The *dominant strategy equilibrium*, consists of choices that are clearly the best players may achieve while the *Nash equilibrium* is determined by choices that are optimal responses to the selections of the other players and the *focal point equilibrium* describes an outcome that seems plausible or fair to all players[367]. *Nash equilibrium* got its name after the mathematician John Nash, who proposed the concept in 1950[368] [369]. Its basic premise is that every change or choice of a new strategy affects also the strategies of the other player or players. Players make the best possible decision by taking into account also the decisions of other players[370]. It is an interesting historical oddity that the solution concept named after Nash was put forward in only slightly different form by Cournot in 1838. The *Cournot strategy* for an oligopolistic firm, in which the firm produces the output that maximizes its profit given the outputs the other rival firms are producing,

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[360] (Waltz, 2008)
[361] (Waltz, 1954)
[362] (Weber, 2009)
[363] (Paravantis, 2015)
[364] (von Neumann & Morgenstern, 1944)
[365] (Jadreskic, et al., 2018)
[366] (Jadreskic, et al., 2018)
[367] (Schelling, 1980)
[368] (Nash, 1950)
[369] (Nash, 1951)
[370] (Jadreskic, et al., 2018)

amounts to the *Nash equilibrium* when all firms follow this strategy[371]. On the other hand, *Pareto optimal* result is such a result of a game in which the result of one player might be better only if the result of another player would get worse [372].Far fewer games than previously thought are game of pure conflict (called *constant* or *zero-sum games*), i.e. most games may be directed to outcomes that benefit all players from the distribution of additional value created by smart strategic choices that enlarge the sum of the expected outcomes (*nonzero-sum games*) [373].

In game theory two kinds of games are possible, noncooperative and cooperative. In cooperative games players coordinate their strategies by making contracts and sharing profit. Their optimal strategy is mutual cooperation. In that case, an agreement is made to bring the greatest possible benefit to both sides. On the other hand, in noncooperative games players have conflicting interests and they try to work for their own benefit, while doing harm to the competitor, so the attention is directed at strategic choices of every player. In the case of a noncooperative game, each player makes his own decisions separately, without cooperation, and this kind of game is presented in the form of a prisoner's dilemma. In the game of prisoner's dilemma, according to the basic presumption of rationality, every player makes a choice for himself that he thinks maximizes his utility. However, as it is suggested when making these decisions, players have to take into account potential decisions of other players, because of a danger that in repeated games they don't bring themselves into a worse position than the initial one. In case of strategy when one player cooperates, and another player doesn't want cooperation, the biggest danger is huge probability of *tit for tat strategy* by cooperative player. Player who refuses cooperation will be punished for his actions. *Tit for tat strategy* is used if one of the players breaks the tacit agreement, and reactions can be multiple, to threats and blackmailing. The first move of this strategy is cooperation, while the next moves are simply repeating previous moves of the competitor. Implicit threat hidden in the *tit for tat* strategy requires players to stick to the agreement. In case of disagreement, mutually incompatible strategies would lead to the status quo position, which would support the current state (see Table 6). In this situation it is possible that two players involved are further aggravated by unsolved issues[374].

Another limit of noncooperative games comes out of a decision of players to maximize exclusively their own benefit, without taking care for how their decision will reflect on the community's wellbeing. Though from the perspective of companies the focus is on profit, from the perspective of the state, the focus is on social wellbeing, and therefore on lower prices[375]. Game theory incorporates key elements of both the realist and liberal views of international politics. It is consistent with realism because the players are assumed to have a unitary will, i.e. each government acts as a single agent rather than as some kind of complex organization whose decisions result from domestic political interactions. At the same time, it shows how self-interested behavior can lead to order and welfare-improving outcomes just as the market economy can. The game-theoretic approach does require that governments are able to rank-order outcomes in a manner that is consistent with agent rationality[376].

In this context, Nash's equilibrium is in the point in which the profit is the biggest. However, player's strategy pays off for both ones only if both players consistently apply it.

[371] (DeCanio & Fremstad, 2013)
[372] (Jadreskic, et al., 2018)
[373] (Paravantis, 2015)
[374] (Jadreskic, et al., 2018)
[375] (Jadreskic, et al., 2018)
[376] (DeCanio & Fremstad, 2013)

They have to decide whether they will engage in rivalry, i.e. competition to individually win as bigger market share as possible, or they will decide for a weaker level of competition maintaining the existing market share with a mutual agreement on the forming of prices. If companies would decide for a multiple repetition of the game, they would see that in the end the best strategy is mutual cooperation. If the game is played only once, then Nash's solution is optimal. If the game is repeated unlimited number of times, then it leads to Pareto optimal result. Mutual cooperation includes cooperative game. Its outcome is the situation where a single player's strategy induces another player to adapt and accept a cooperative plan. Strategy matrix in this game would look like in Table 6 [377].

Table 6: Strategy matrix of two players according to cooperation

		PLAYER B	
	STRATEGY	**Cooperation**	**Non - cooperation**
	Cooperation	**Joint decision-making**	Player B boycotts Player A, potential tit for tat strategy
PLAYER A	**Non-cooperation**	Player A boycotts Player B, potential tit for tat strategy	Position status quo

Source: based on the paper of Jadreskic, Ornella & Cerovic, Ljerka & Maradin, Dario. (2018), The Application of Game Theory in Energetics – Relationship between Poland and Russia. Research Bulletins of the Faculty of Economic Sciences. 1, pp. 89-102, available at: https://www.researchgate.net/publication/322593314

As illustrated in the classic book of Von Neumann and Morgenstern[378], the broader discipline of business and economic activity is a suitable area for applying game theoretic tools. When companies try to increase the pie, as when opening up new markets, then it is to their interest to cooperate; when attempting to increase their share of the pie, as when they try to split up existing markets, then it is to their advantage to compete. Hence, the mixed type of business interaction, called *"co-opetition"* (i.e. cooperative competition) [379]. While Von Neumann and Morgenstern[380] laid the foundations for the application of game theory in economics, it was Schelling[381], a Nobel Prize winner that first showed how it may be used as a tool for the analysis of conflict in IR[382].

Having completed the presentation of key game theory concepts, attention now shifts to a game theoretic outline of international negotiations through which the world tries to solve global environmental problems. Such negotiations are usually placed under the auspices of supranational organizations such as the European Union (EU) or the United Nations. As reported by Brandenburger and Nalebuff for the case of businesses, the relationship between national and other agencies of global politics, can best be described as cooperative competition (co-opetition)[383]. Transboundary environmental problems such as those related to the anthropogenic contribution to global climate change and the promotion of sustainable development often put countries that are long-term partners and allies, to rival positions on specific environmental issues. Susskind writes that negotiations on global environmental problems take months, years or even decades and eventually culminate in international environmental meetings such as those of Rio de Janeiro (1992, United Nations Conference

[377] (Jadreskic, et al., 2018)
[378] (Von Neumann, & Morgenstern, 1944)
[379] (Bradenburger & Nalebuff, 1996)
[380] (Von Neumann, & Morgenstern, 1944)
[381] (Schelling, 1980)
[382] (Paravantis, 2015)
[383] (Bradenburger & Nalebuff, 1996)

on Environment and Development, also known as the Earth Summit) or Kyoto (1997, United Nations Framework Convention on Climate Change). Stakeholders in such international environmental meetings include businesses, industries, environmental groups, activists and scientific organizations. Groups not participating in such conferences necessarily rely on representatives to articulate and support their opinion, so meeting participants are under pressure from many interests that want to influence their position. As Susskind mentions, these organizations oftentimes have different agendas and priorities, e.g. Brussels would not want the European negotiating committee to take a position that damages the EU's relationship with allies and partners in other bilateral negotiations such as those on security or economic cooperation. They may even reject a treaty that could harm their constituency, even if the treaty would benefit the rest of the country or the world, a behavior contrary to the motto of "think globally, act locally". To get a sense of the difficulty, it should be kept in mind that global environmental negotiations try to reach an agreement among 170 national delegations, each with its own political agenda, which is in delicate balance with many internal pressures[384] [385].

Obviously, the more countries participate, the more difficult it is to reach an agreement. Thus, ambitious plans are often reduced to a small number of real achievements. The conference in Rio, for example, when planned in 1989 by the United Nations General Assembly intended to contain nine individual treaties, which would deal with climate change, transboundary air pollution, deforestation, loss of territories, desertification, biodiversity, protection of the oceans, protection of water resources and, finally, strategies to finance all these measures. Eventually, agreement was reached only on the issues of climate change and biodiversity, with the treaty framework on climate change containing no specific goals or timetable. These are the weaknesses that the 1997 Kyoto summit attempted to correct, although the Kyoto Protocol that was agreed upon, has registered in history as yet another international action in which the world agreed half-heartedly on an extremely costly and inefficient protocol, with the United States of America not willing to participate, Canada announcing its retirement on December 12th, 2011 and China and India aware that it was not to their interest to participate. Naturally, the Kyoto accord had strong communication value in local political audiences. Later on, attention shifted to Copenhagen (2009), Cancun (2010) and, lately, Durban (2015), which have undertaken the onerous task of keeping the Kyoto Protocol alive, despite its significant failings[386].

Game-theoretic models provide an elegant formalization of the strategic interactions that underlie the international climate negotiations. There is a long and lively tradition of applying game theory to problems of international relations, including global environmental protection. Starting with the *"New Periodic Table"* (NPT) of 2×2 order games introduced by Robinson and Goforth[387], Stephen De Canio and Anders Fremstad in their paper provided an exhaustive treatment of the possible game-theoretic characterizations of climate negotiations. For them, the climate negotiations between two players (e.g., Great Powers or coalitions of states) may be game-theoretically characterized as a Prisoner's Dilemma, a No-Conflict Game, a Coordination, a Chicken or other types of game, depending on the payoff matrix. As they argued, assessment of the magnitude of the global climate risk is the key determinant of the kind of *"game"* being played. This in turn affects the feasibility of reaching an agreement, and the possible role of equity considerations in facilitating an

[384] (Susskind, 1994)
[385] (Paravantis, 2015)
[386] (Paravantis, 2015)
[387] (Robinson & Goforth, 2005)

agreement. As a result which game corresponds to the actual state of the world depends both on the severity of risks associated with climate change and the perceptions of the governments engaged in the negotiations. *Nash equilibrium* or *Maxi-min equilibrium* (or neither) may be the outcome. In particular, scientific information pointing to the severity of the risks of climate change suggests characterization of the negotiations as a *Coordination Game* rather than a *Prisoner's Dilemma*[388] but scientific uncertainty puts in question this assumption. Achieving universal abatement of GHG emissions may require side payments or enforcement mechanisms outside the game framework, but the negotiations themselves may offer opportunities to select between *Nash equilibria* or alter the payoff rankings and strategic choices of the players[389].

Arguing that the essence of many international relations situations can be captured by the simple 2×2 framework, Stephen De Canio and Anders Fremstad consider the simplest possible games. There are only two players, who will be identified as “Row” and “Column.” The games are interpreted as representing different kinds of international relations, sometimes Great Power rivalry (as between the United States and China, for example) and sometimes other strategic interactions (as between the relatively rich OECD countries and the relatively poor developing nations). Each player chooses one of two strategies, “Abate” or “Pollute”. Furthermore, establishing which of the 2×2 games are potentially applicable to the climate problem, they narrow down the number of games by requiring that the payoff structures satisfy two *climate relevant restrictions*: (1) The outcome (Abate, Abate) is preferred by both players to the outcome (Pollute, Pollute), and (2) Each player's pollution imposes a negative externality on the other. These two climate-relevance conditions apply to countries' GHG emissions. The first of them amounts to assuming that there is no economic or geopolitical advantage to be gained by either party if both pollute instead of both abating, and that the climate problem is real. It does not require that climate is either party's top priority. The second restriction amounts to the presumption that neither party's pollution benefits the other party. A small country rich in oil or gas reserves may derive much of its national income from the export of its fossil fuel resources. From a short-term perspective, the government of such a country might prefer that the rest of the world adopt the Pollute strategy, violating the “negative externality” condition (2). This situation might apply to a few countries, but not to the major powers[390].

According to their assumption, an international climate agreement may reduce the risk of climate change correcting a market failure (allowing free disposal of GHG into the atmosphere) but would create a pecuniary externality by causing a loss of fossil fuel wealth and revenues to OPEC members. Pecuniary externalities are typically considered to be also part of the dynamic market process and are in fact necessary for allocational efficiency, even though the political process makes no distinction between them and “real”ones. In addition, they do not consider the thinly-supported claims that some countries or regions would benefit from global warming. The world is already committed to some amount of warming because of cumulative emissions to date, and the pending policy question is how much more warming can be allowed, so as to avoid “*dangerous anthropogenic interference with the climate”*[391].

[388] (DeCanio & Fremstad, 2013)
[389] (DeCanio & Fremstad, 2013)
[390] (DeCanio & Fremstad, 2013)
[391] (DeCanio & Fremstad, 2013)

1. *The 'No-conflict' game*

Stephen De Canio and Anders Fremstad in their paper argued that there is no reason to assume from the outset that the climate problem is inherently one of international conflict. There are a number of games satisfying the two climate relevance restrictions in which reaching an international agreement should be relatively easy. As it appears in Table 7, these no-conflict games have a payoff of (4, 4) for the (Abate, Abate) strategy choices, although they are not the only interesting games with this pattern. Rational players will settle on the (Abate, Abate) strategy pair whether they are following *Nash* or *Maxi-Min* strategies[392].

Table 7: Climate policy as a no-conflict game

	Abate	**Pollute**	
Abate	**4,4**	2,3	Row's DS = Abate
Pollute	3,2	1,1	Column's DS = Abate

Source: Stephen J.DeCanio, AndersFremstad, 2013, Game theory and climate diplomacy, Ecological Economics 85, pp. 177-187, available at: https://www.sciencedirect.com/science/article/pii/S0921800911001698,https://eclass.gunet.gr/modules/document/file.php/LABGU362/Game%20theory%20and%20climate%20diplomacy%202013.pdf

As it s already mentioned, *Nash equilibrium* is defined as an outcome such that neither Row nor Column can improve its payoff by deviating unilaterally from the outcome if the other continues to play the equilibrium strategy. Clearly, if both are playing Abate in this game, neither has any incentive to "defect" and begin polluting. Indeed, Abate is the *dominant strategy* for both players. This means that Row's payoff for playing Abate is greater than its payoff for playing Pollute, no matter what strategy Column chooses. The same is true for Column; its payoff to playing Abate is greater than its payoff from playing Pollute no matter what Row does. According to Stephen De Canio's and Anders Fremstad's assumptions, the *Nash equilibrium* is the most familiar equilibrium concept, but it is not the only possible one. The *Maxi-min strategy* is a strategy for which the worst possible payoff is at least as good as the worst payoff from any other strategy. The Maxi-min payoff is the highest payoff that a player can guarantee herself[393].In this case, the *Nash equilibrium* and the *Maxi-min equilibrium* are the same, but this is not the case for all the 2×2 games. The *Maxi-min strategy* guarantees for a player the best outcome that can be had regardless of the strategy of the other player. No assumption needs to be made about the other player's rationality, strategic behavior, or motivations. A player using *Maxi-min* is truly *"on his own"*. Extremely risk-averse players might well choose *Maxi-min* and this could be the route by which climate stability is reached[394].

Stephen De Canio and Anders Fremstad conclude admitting that, even in the case of *"no-conflict"* games, where only one player has a *dominant strategy*, and the *Maxi-min equilibrium* is sub-optimal in the sense that each player could achieve its best outcome, if both play Abate, there might be a need for international cooperation to get the parties to understand that (Abate, Abate) is *Pareto-superior* to any other outcome. Negotiations could serve to build trust among the parties whose tendency might otherwise be to *"go it alone"*.

[392] (DeCanio & Fremstad, 2013)
[393] (Robinson & Goforth, 2005, p. 163)
[394] (DeCanio & Fremstad, 2013)

Indeed, it may be that the success of the Montreal Protocol[395] can be explained by its belonging to this category. The damage from stratospheric ozone depletion may have been seen as so serious to major countries like the United States that abatement of the ozone depleting substances was a *dominant strategy*, and the *Nash equilibrium* was universal abatement[396]. Barrett argues that accession to the Montreal Protocol was a dominant strategy for most industrialized countries[397].

To this context John Paravantis pointed out in his paper that *"international environmental problems such as global climate change are characterized by considerable scientific uncertainty, which surely affects their solution by bargaining"*. He also cited Baron's argument, who stressed the uncertainty in the forecasts for global climate change expected from man-made global warming comparing it to that of the ozone layer, where the international community was in possession of actual measurements of the formed hole instead of mere predictions of computer models (as in the case of greenhouse gases) [398]. According to John Paravantis *"this scientific certainty may have contributed to the speed and efficiency that characterized the cooperation of the international community on the issue of the ozone hole"*. On the other hand, global climate change is related to CO2 emissions, which in turn are related to the economic development of countries. Indecision characterizes the global community in its effort to combat global warming which surely has more complex economic and political dimensions than the problem of the ozone layer[399].

Stephen De Canio and Anders Fremstad also wondered why the climate problem seems so difficult, if reaching the optimal outcome were so easy. Up to their conclusion the ease of arriving at the *Pareto-superior equilibrium* in these games may be seen as evidence that these games do not capture the payoff structure of international climate diplomacy[400]. Despite long-term negotiations, beginning with the UNFCCC[401] in Rio de Janeiro in 1992 and continuing with the Kyoto Protocol in 1997[402] and Paris Agreement in 2015[403] little progress has been made. There is no global agreement committing all the major powers to specific emissions reductions. The United States' late legally binding commitment to reduce its own GHG emissions, the second largest after China[404], was cancelled during Donald Trump's presidency, which has led to the US withdrawal from the Paris agreement on June 1, 2017 incentivizing investments in carbon-intensive, environmentally destructive fossil fuel projects. Whats'more Russia and Turkey have abandoned plans to ratify, while Australia reversed a decision to implement measures to comply with its Paris pledge and the newly elected president of Brazil, Jair Bolsonaro, has promised to withdraw from the Paris Agreement, all citing Trump's withdrawal decision. Although other major players including the European Union, India, and China remain committed to the Paris Agreement and are on track to achieve their targets, they are unlikely to take the political risks of announcing a more challenging one in the absence of a similar commitment from the United States, even

[395] Montreal Protocol on Substances that Deplete the Ozone Layer (with annex). Concluded at Montreal on 16 September 1987, available at: https://treaties.un.org/doc/publication/unts/volume%201522/volume-1522-i-26369-english.pdf
[396] (DeCanio & Fremstad, 2013)
[397] (Barrett, 2003, pp. 229-230)
[398] (Baron , 1998)
[399] (Paravantis, 2015)
[400] (DeCanio & Fremstad, 2013)
[401] (United Nations , 9.05.1992)
[402] (United Nations, 1997)
[403] (United Nations, 2015)
[404] (European Commission, 2014)

if they already have the technical ability to achieve it[405].Through this lack of agreement on climate they finally suggest that the climate problem is not one of the *"no conflict"* games[406].

2. *Prisoner's dilemma*

The Prisoner's dilemma, a byproduct of the Game Theory is the best known game theoretic model of transnational cooperation. Its concept was developed by RAND Corporation scientists Merrill Flood and Melvin Dresher and was formalized by Albert W. Tucker, a Princeton mathematician. Its original scenario is thoroughly described by Axerlod[407]and Rapoport & Chammah[408]. It refers to a situation, wherein an individual has to choose between self-interest and mutual interest. Betrayal of trust for individual gain is a common phenomenon. Normally individuals, as rational actors protect their own interests, without cooperating with others but this finally proves to be harmful to all.

According to John Paravantis analysis, it's about *"two suspects, who not allowed to come in contact, may either keep their mouth shut or confess their crime and give their partner away. If both manage to keep their mouth shut, they are put in prison for a very short time. If only one confesses (the snitch) and the other keeps his mouth shut, the snitch is released while the other goes to jail for a very long time. Finally, if they both snitch, they both go to jail for a moderately long time. Such is the structure of this remarkable game that a powerful outcome emerges in which they both choose to confess, each one in the naïve hope of being released, but since they both snitch on one another, they both go to prison for a moderately long time"* [409] (Table 8).

Table 8: The game of prisoner's dilemma

	Prisoner B stays silent (cooperates)	**Prisoner B betrays A (defects)**
Prisoner A stays silent (cooperates)	Each serves 1 year	Prisoner A: 3 years Prisoner B: goes free
Prisoner A betrays B (defects)	Prisoner A: goes free Prisoner B: 3 years	Each serves 2 years

Source: Evan Abrams , 9.05.2013 , Climate change is the ultimate prisoners' dilemma, Global Risk Insights, available at: https://globalriskinsights.com/2013/05/climate-change-is-the-ultimate-prisoners-dilemma/

He adds that an analyst may be pretty confident that they will both select to confess (i.e. snitch) because this is a *dominant strategy*, and the unfortunate outcome of both snitching on one another is a *dominant strategy equilibrium*, the strongest solution concept in game theory. This game belongs to the class of social dilemmas[410], which are characterized by the existence of a cooperative solution (e.g. both keep their mouth shut) that is distinct from the game equilibrium (e.g. both snitch on one another)[411]. In this game *Nash equilibrium* is at the point where the earnings of both players are greatest. According to Jadreskic, Cerovic and Maradin's game theoretic analysis, ultimately the optimal strategy for both players is cooperation, presented through the game of cooperation. However, actual relations are not

[405] (Curtin , 2018)
[406] (DeCanio & Fremstad, 2013)
[407] (Axelrod, 1985)
[408] (Rapoport & Chammah, 1965)
[409] (Paravantis, 2015)
[410] (McCain, 2004)
[411] (Paravantis, 2015)

Pareto optimal, and their mutual 'games' are not ending[412]. Although the best option for both suspects is to remain silent and not testify against the other, a lack of trust and confidence in the other may compel one of them to testify leading to a harmful outcome to all. In that case choosing self-interest might not be of any value to anyone, if the others too think selfishly. On the contrary mutual trust leads to a win-win situation of mutual gain. However, anyone that thinks of the group's interest risks of ending up bearing all the loss, in case others act driven by their own interests. This insecurity does not allow people to trust each other, resulting in a lose-lose situation. Similarly, on the global level, nations face great difficulties in cooperating with each other, at the expense of the mankind's good.

David Bartolini identified coordination failures according to the degree of alignment of agents' objectives, which depends on their preferences. In his research a *coordination failure* is defined according to the concept of Pareto efficiency, i.e. the outcome of the interaction is *not Pareto efficient*. Precisely in the two-player game of Prisoner's dilemma, the strategy of non-cooperation for both players ends up being the unique *Nash equilibrium* (*dominant strategy*). For him, the problem is the presence of an incentive to *free-ride*, i.e., both players have an incentive not to coordinate on the cooperative strategy[413]. As an example Susskind[414]analyzing the diplomacy of international negotiations on global environmental problems such as the global climate change described the phenomenon of pollution havens[415]. In this context John Paravantis presents the case of some developing countries who deliberately loosen up their environmental standards in order to attract foreign investments. According to his description *"these countries gain a competitive advantage over economically developed countries that implement stricter environmental regulations, and as a result have an advantage in exporting their wastes to pollution haven countries that are in a position to provide much more inexpensive environmental compliance oftentimes at the cost of the quality of life of their citizens"*[416]. According to Bartolini, in case of not aligned objectives it is fundamental that the relationship is repeated a potentially infinite number of times. Problems of *moral hazard* are even more acute. A social norm needs a prescription of punishment in case of non-compliance[417].

Global climate change has been on the international agenda since at least 1992 and yet, despite high hopes and a nearly universal recognition that something ought to be done to address the problem, little progress has been made. Various explanations for this failure have been offered and many of the most compelling point to the logic of game theory. As it was argued in Evan Abrams's article in Global Risk Insights, *"the difficulty in rallying disparate nations to collectively fight against climate change demonstrates that the issue is the ultimate prisoner's dilemma"*. The traditional model, illustrated above, can be mapped onto the problem of climate change. The best individual outcome for any country would be for them to defect (continue to pollute) while other nations cooperate (reduce their emissions). This would give the defecting country a competitive advantage over other nations who had to limit their use of fossil fuels. This is also frequently referred to as a *free rider problem*. Then he admitted that although the evidence for climate change is overwhelming and the broad contours of the problem are well established, there is significant debate over what exactly a climate model payoff structure should look like. To this context he described the fact that

[412] (Jadreskic, et al., 2018)
[413] (Bartolini, 2012)
[414] (Susskind, 1994)
[415] (Neumayer, 2001)
[416] (Paravantis, 2015)
[417] (Bartolini, 2012)

even if all parties cooperated on an agreement there would be no guarantee their actions would be enough to prevent significant warming. In this situation cooperating parties would get the negative effects of climate change and still be forced to reduce their fossil fuel dependence[418].

Similarly, he wondered about the exact costs of economic adjustment under a climate agreement and their distribution, as a critical aspect to the climate model of the prisoners' dilemma. He also stated that the traditional game assumes that each party faces an identical payoff structure, whereas in the case of climate negotiations an emission trading system, like the EU ETS, would undoubtedly produce winners and losers through the emission credits transactions between the parties and that countries face different costs when it comes to the effects of climate change itself depending on their size and their political power. By assuming that the US, EU, and China would clearly all need to be involved in any comprehensive climate agreement with a significant impact, he concluded that the incentive to defect would be higher for some parties than others, as the defection of just one of these major parties would likely kill any deal whereas some smaller, less industrialized nations would add almost nothing to emissions reductions even if they entered into a new arrangement. For these countries free riding seems to be a logical choice since they contribute little to the problem and their efforts to solve it would be negligible. As he pointed out the general logic of the game still stands with regard to the incentive to defect and cooperation thus being difficult to enforce but it is vastly complicated by a high number of players, a lack of perfect information regarding the payoff structure, and an asymmetric incentive scheme for the negotiating parties. The severity of climate change and the immediate need for countries to address is undoubted but given the game theory highlighted above, the odds of solving this problem in time to prevent its worst effects seem to be low[419].

According to Stephen De Canio and Anders Fremstad, the non-zero sum game of Prisoner's Dilemma, is a good candidate for characterizing the real-world situation as GHG controls through an intervention in the energy sector strikes close to the heart of an industrialized nation's economic strength, so that countries with global influence fear that they would be weakened if required to scale back their energy production and consumption or substitute more expensive primary energy sources for fossil fuels.Taking into consideration that the highest priority of each country is to avoid a decline in its economic and military strength relative to the other, they assume that both countries would benefit from jointly reducing emissions by playing Abate, but because abatement of emissions is costly, the worst outcome for either one (at least in the short run) is to play Abate while the other continues business as usual (i.e., polluting). As it appears in Table 9, in climate diplomacy as a Prisoner's Dilemma, the unique *Nash equilibrium* is that both play Pollute and the payoff is (2, 2). In other words, defection is both countries' *dominant strategy*. If, Row were to deviate and try playing Abate while Column continues to play Pollute, the payoff to Row would be 1, less than what Row receives when both play Pollute. Similarly, if Column were to deviate and play Abate while Row plays Pollute, Column's payoff would drop from 2 to 1. Both countries would be better off if they could somehow negotiate an enforceable international agreement to Abate, but this would be quite difficult because for both countries the highest priority is to prevail in geopolitical/military and economic competition and each would always have an incentive to defect. For example, if both were playing Abate, Column could improve its payoff from 3 to 4 if it began to play Pollute while Row continued to Abate.

[418] (Abrams, 2013)
[419] (Abrams, 2013)

On the contrary, both countries' least-preferred outcome is to Abate while the other Pollutes (free rider)[420].

Table 9: Climate policy as a game of prisoner's dilemma

	Abate	Pollute	
Abate	3,3	1,4	Row's DS = Pollute
Pollute	4,1	2,2	Column's DS = Pollute

Source: Stephen J.DeCanio, Anders Fremstad, 2013, Game theory and climate diplomacy, Ecological Economics 85, pp. 177-187, available at: https://www.sciencedirect.com/science/article/pii/S0921800911001698,https://eclass.gunet.gr/modules/document/file.php/LABGU362/Game%20theory%20and%20climate%20diplomacy%202013.pdf

In their research they also explain that each country is a sovereign entity, so the problems of compliance, verification, and free-riding are salient. In contrast to the outcome of (Abate, Abate) which is *Pareto-superior* to the outcome when both play Pollute, the *Nash equilibrium* (Pollute, Pollute) is self-enforcing in the sense that neither country has an incentive to deviate from it[421]. In this context Manuel Chavez-Angeles also noted that in the game of prisoner's dilemma, as both players make high emissions at the same time cheating is preferred to cooperation. For him, the reason is that the structure of payments is such that for a player or country there are incentives to cheat even when the other is cooperating. In this scenario no matter what the other player does, defection yields a higher payoff then (*dominant strategy*)[422]. Stephen J.DeCanio AndersFremstad proposed the arrangement of side payments drawn from the surplus generated by the difference between the (3, 3) and (2, 2) outcomes, so as for the outcome (Abate, Abate) to be achieved and for defection to be discouraged. However, they warn that the transferrable surplus might not be large enough to deter defection. What's more, if it were known that side payments were possible, each party would have an immediate incentive to announce its intention to defect. Other ways out of the PD focus on creating incentives to stay at the Pareto-superior outcome in which both Abate, by bringing in rewards and punishments that are outside the structure of the game's payoffs. Public goods (such as pollution abatement) are provided within States by enforcing environmental laws with the police power including provisions for civil and criminal penalties for those who pollute. In the international arena, treaties can be designed that impose trade sanctions on countries that do not join and comply. If the game were played repeatedly, then a *"tit for tat"* punishment/reward strategy could be employed to train all the parties in the benefits of cooperation[423].

Consequently, as it is indicated in Table 10, in the case of climate diplomacy, just like in prisoners'case, nations have to choose between self-interest meaning their economic development and mutual interest meaning the salvation of the planet. Betrayal of trust is common between nations, as well. Nations just like individuals are rational actors who prefer to increase their exports and subsequently their Current Account Balance and their GDP acquiring a competitive advantage to others nations internalizing the externalities of GHG emissions unstead of unifying their powers under a legally binding agreement against climate change but this finally proves to be harmful to all (global warming). According to the game theoretic analysis, nations' *dominant strategy* is to defect and quit international climate

[420] (DeCanio & Fremstad, 2013)
[421] (DeCanio & Fremstad, 2013)
[422] (Chavez-Angeles, 2016)
[423] (DeCanio & Fremstad, 2013)

agreements (*"Trump effect"*[424]), in order to maximize their economic growth. In this context, the existence of a cooperative solution (e.g.international agreement on the decarbonisation of the global economy) is distinct from the game equilibrium (e.g.nations' defection so as to gain competitive advantage). In this game *Nash equilibrium* is at the point where the earnings of both nations are greatest. Ultimately their optimal strategy is cooperation, presented through the game of cooperation. However, actual relations are not *Pareto optimal* and as a result, although the best option for all is to abate reducing their GHG emissions and not pollute, a lack of trust and confidence in the other may compel one of them to pollute leading to a harmful outcome to all. In that case choosing self-interest might not be of any value to any nation, if all the nations think selfishly at the expense of the humanity whereas mutual trust would lead to a win-win situation of the planet's salvation. However, similarly to the prisoners' case, any nation that thinks of the good of the Mankind, risks of ending up bearing all the loss, in case other nations act with their mind on their own economic development (free riders). As a result, nations face great difficulties in cooperating with each other, at the expense of the planet.

Table 10: The problem of Climate Change mitigation as ultimate prisoner's dilemma.

	Nation B cooperates (reduces its emissions)	**Nation B defects (continues to pollute – high emissions – carbon leakage)**
Nation A cooperates (reduces its emissions)	Nations A & B: Increased costs => SHARED decreased GDP BUT SALVATION OF THE PLANET the consumer base will be divided	Nation A: limit the use of fossil fuels=> increase of cost => increase of prices => decrease of exports Nation B: competitive advantage (free rider)=>increase of exports => max GDP
Nation A defects (continues to pollute – high emissions – carbon leakage)	Nation A: competitive advantage (free rider) => increase of exports => max GDP Nation B: limit the use of fossil fuels => increase of cost => increase of prices => decrease of exports	Nations A & B: EQUAL HIGH GDP BUT GLOBAL WARMING the consumer base will be divided

Source: based on Evan Abrams's assumptions in the article "Climate change is the ultimate prisoners' dilemma" in Global Risk Insights" on the 9th May 2013, available at: https://globalriskinsights.com/2013/05/climate-change-is-the-ultimate-prisoners-dilemma/

In his context John Paravantis in his paper stated: *"Real decisions are made under conditions of limited rationality and incomplete information. Deviations from the assumption of perfect rationality make a player select outcomes with suboptimal payoffs leading to suboptimal collective decisions. People tend to decide and act in a way that favors the nations to which they belong, even if that harms third parties belonging to groups that are foreign or unrelated to them"*[425]. Baron asserts that such systematic judgmental errors play a role in global environmental concerns such as global climate change[426].

[424] (Curtin , 2018)
[425] (Paravantis, 2015)
[426] (Baron , 1998)

3. *The Coordination game*

A remarkable fact is that there is another climate-relevant game that shows the same kind of priority given to geopolitical competition as the Prisoner's Dilemma and yet offers a much greater possibility for international cooperation. Stephen De Canio and Anders Fremstad considered a slight modification to the Prisoner's Dilemma payoff structure in which both countries would be highly averse to playing Abate while their rival plays Pollute, but where the very best outcome for both would be jointly to play Abate. This would eliminate the incentive to defect, provided an agreement by both parties to play Abate could first be reached. The worst outcome for either country would be to abate while the other pollute, just as in the Prisoner's Dilemma. One country's playing Abate while the other plays Pollute continuing business as usual leads to losing out in the short-run geopolitical competition and eventually results in disastrous destabilization of the atmosphere also[427]. Avoiding a high probability of exceeding a 2 °C temperature increase requires the world as a whole to reach zero net emissions this century. As it is argued *"there is no room in the atmosphere for any major economy to continue business as usual without running the risk of dangerous anthropogenic interference with the climate system for everyone"*[428].

According to Stephen De Canio's and Anders Fremstad's analysis, the next-to-worst outcome for both Great Powers is that they both pollute. In this case there is significant risk that the planet is destroyed but at least, neither gains geopolitical advantage in the short run. The best outcome for both is that they both abate. In this case, neither Great Power is disadvantaged politically nor does the planet run the risk of climate catastrophe. As a result in this game, there are two *Nash equilibria*: either both countries play Abate and both play Pollute. The diplomatic problem here is one of equilibrium choice. If the system could be gotten to (Abate, Abate) it would stay there. The payoff structure is such that an international climate agreement would be self-enforcing. Equity considerations might well play a role in the equilibrium choice, because the Pareto-superior outcome in which both players Abate would be one in which the world environment is more benign, and nations might therefore be more likely and more able to devote resources to other objectives like poverty elimination or sustainable development. The game structure depicted in Table 11 is sometimes referred to as *"Stag Hunt"*. The story is that two individuals can cooperate to hunt a stag, or each can go his own way and hunt a hare. Without cooperation, the stag hunt is guaranteed to fail, but either hunter can easily bag a hare on his own. The terminology stems from an example given by Rousseau. A similar situation in which there is a substantial payoff to social cooperation is Hume's example of two occupants of a boat who can make progress only by rowing together[429]**.** In this context Manuel Chavez-Angeles in his paper proposed a cooperative solution where players with low emissions would receive transfers from the carbon bond market while players with high emissions would pay an environmental tax derived from their profits through their main commercial activity. Several fiscal policies involving government transfers could be put in place in order to achieve an equilibrium with at least one player with low emissions[430].

[427] (DeCanio & Fremstad, 2013)
[428] (Ackerman, et al., 2009)
[429] (DeCanio & Fremstad, 2013)
[430] (Chavez-Angeles, 2016)

Table 11: Climate policy as a Coordination game

	Abate	Pollute
Abate	**4,4**	1,3
Pollute	3,1	**2,2**

Row's DS = Abate or Pollute

Column's DS = Abate or Pollute

Source: Stephen J.DeCanio, AndersFremstad, 2013, Game theory and climate diplomacy, Ecological Economics 85, pp. 177-187, available at: https://www.sciencedirect.com/science/article/pii/S0921800911001698,https://eclass.gunet.gr/modules/document/file.php/LABGU362/Game%20theory%20and%20climate%20diplomacy%202013.pdf

Stephen De Canio and Anders Fremstad also pointed out the fundamental differences between Coordination Game and Prisoner's Dilemma. Even though Great Power rivalry and concern over the relative payoffs are built into the payoff structures of both games and both games exhibit the classic collective action problem, in that the worst outcome for a player is to abate (i.e., contribute to paying for the public good) while the other player is a free rider, in the Coordination Game, the highest-valued outcome for both parties is achieved when they cooperate, while in the Prisoner's Dilemma the best outcome for a party is to Pollute while the other Abates[431]. They also answer to their question if global climate protection is more like a Prisoner's Dilemma or a Coordination Game that it depends on how severe the risk of catastrophic climate change is considered to be. For them, the presence of a (4, 4) payoff means that, if it can be reached, neither party will have an incentive to defect. If there is scientific certainty that climate change is an existential threat to humanity and civilization, at a non-zero probability of sufficient magnitude that it cannot be ignored, then the world is in a Coordination Game. Even if Great Power rivalries and geopolitical competition are strong, there is still sufficient advantage to cooperation to make (Abate, Abate) a sustainable and self-enforcing equilibrium, provided it can first be reached. On the other hand, if nothing, not even survival, is more important than winning geopolitical advantage over the other competing powers, the Prisoner's Dilemma characterizes the situation and the outlook for cooperation is dim. This simple comparison between the Prisoner's Dilemma and the Coordination Game demonstrates that the overriding barrier to achieving an international agreement to protect the climate may be a failure of the leading governments to grasp the seriousness of the climate risk. Although the governments of all Great Powers care deeply about their relative power and survival in the short run, in a Coordination Game, it would be entirely plausible that self-interest, in some cases reinforced by equity considerations, could help push the system into the Pareto-optimal (Abate, Abate) equilibrium[432].

Economic theory does not offer a clear or firm answer to the problem of equilibrium choice when there are multiple equilibria. Nevertheless, if the Coordination Game corresponds to the real-world situation, intelligent diplomacy holds the promise of being able to reach the *Pareto-optimal* outcome of (Abate, Abate). It is easy to imagine the world's initially being in the (Pollute, Pollute) *Nash equilibrium* because awareness of the climate change problem is so recent, and that considerable effort and adjustment would be required to attain mutual Abatement. Relatively sudden realization of the magnitude of a global environmental risk is consistent with the history of the negotiation and subsequent success of the Montreal Protocol[433].

4. *The Chichen game*

[431] (DeCanio & Fremstad, 2013)
[432] (DeCanio & Fremstad, 2013)
[433] (DeCanio & Fremstad, 2013)

The game of chicken is defined as a model of conflict for two players in game theory. It has its origins in a game in which two drivers drive towards each other on a collision course: one must swerve, or both may die in the crash, but if one driver swerves and the other does not, the one who swerved will be called a *"chicken"*. The principle of the game is that it is mutually beneficial for the players to play different strategies and thus it is an anti-coordination game, the opposite of a coordination game, where playing the same strategy Pareto dominates playing different strategies. According to Rapoport's and Chammah's assumption this game's underlying concept is that players use a shared resource, which is rivalrous but non-excludable and sharing comes at a negative externality whereas in coordination games, sharing a nonrivalrous resource creates a positive one for all. Because the loss of swerving is so trivial compared to the crash that occurs if nobody swerves, the reasonable strategy would seem to be to swerve before a crash is likely. Yet, knowing this, if one believes his opponent to be reasonable, he may well decide not to swerve at all whereas in the belief that his opponent won't be reasonable, he may decide to swerve leaving the other player the winner. This unstable situation can be formalized by saying that *'there is more than one Nash equilibrium, which is a pair of strategies for which neither player gains by changing his own strategy while the other stays the same"* [434].

Stephen De Canio and Anders Fremstad also in their paper inspecting the chicken game's payoff matrix considered it as a climate-relevant one. Arguing that row's payoffs are lower if Column plays Pollute than if Column plays Abate, and vice-versa, as it appears in Table 12, they concluded that chicken game has two *Nash equilibria*, which are for one party to pollute while the other Abates. As they noted, however, the Nash equilibrium is not the only possible equilibrium concept. *Risk-aversion* is usually thought of as being a characteristic of the parties' preferences, but it may alternatively describe their choice of strategies. The parties may operationalize their risk aversion by selecting Maxi-min strategies. The outcome when both parties play *Maxi-min strategies* is (Abate, Abate). Highly risk-averse parties behaving in this way might reach this outcome arriving at an equilibrium different from one of the Nash equilibria. As a result, in chicken game neither party has a *dominant strategy* while the least-favored outcome for both parties is (Pollute, Pollute). This coupled with the risk-averse choice of Maxi-min strategy leads to the (Abate, Abate) outcome[435].

Table 12: Climate policy as a game of chicken

	Abate	**Pollute**	
Abate	**3,3**	2,4	Row's DS = Pollute when the other Abates
Pollute	4,2	1,1	Column's DS = Pollute when the other Abates

Source: Stephen J.DeCanio, Anders Fremstad, 2013, Game theory and climate diplomacy, Ecological Economics 85, pp. 177-187, available at: https://www.sciencedirect.com/science/article/pii/S0921800911001698,https://eclass.gunet.gr/modules/document/file.php/LABGU362/Game%20theory%20and%20climate%20diplomacy%202013.pdf

Furthermore they argued that as in the case of the Coordination Game, it would be possible to reach a mutual abatement equilibrium without any side payments or changes in the countries' preferences if greater understanding of the risks of climate change were to induce both to adopt a Maxi-min strategy. For them only the country that wouldn't have a dominant strategy would have to play a Maxi-min strategy to get to the (Abate, Abate) outcome. As with the Coordination Game, it would be quite possible to imagine negotiations

434 (Rapoport & Chammah, 1966)
435 (DeCanio & Fremstad, 2013)

serving the function of persuading the country inclined to pollute of the dire risks posed by uncontrolled climate change. Nevertheless they admitted that there is a downside to the Maxi-min strategy in these games: one party (or both parties in Chicken) has an incentive to defect from the Maxi-min equilibrium. The defecting party can, in effect, exploit the risk averseness of the Maxi-min player. While playing a Maxi-min strategy can be attractive to a risk-averse player, it may allow a more ruthless competitor to gain the advantage by defecting from the Maxi-min equilibrium. As a result prior commitment to abate by the nation whose dominant strategy is Abate would guarantee that the other will pollute. Only if the other nation follows a *Maxi-min strategy* can the (Abate, Abate) outcome be obtained, and this would not happen if the first party announced in advance of the play of the game that it will abate[436].

Manuel Chavez-Angeles in his paper characterized the fact that in chicken game players do not have a dominant strategy but multiple equilibria, as a signaling problem where each player wants to deviate its competitor from doing the same thing he is doing. For him, players are on a matching problem where the player with low emissions is searching for the player with high emissions and vice versa. Then assuming that production of low or high emissions imply different technologies and therefore different costs he proposed the sale of players' with low emissions carbon assets to those with high emissions through an emissions trading system, as a solution to the above inequalities that result in a chicken game[437]. In this context, according go the UNFCCC principle of *Common but Differentiated Responsibilities and Respective Capabilities*, developing countries were given the opportunity to upgrade their infrastructure through investments financed exactly with the revenues of carbon assets' transactions. However, because of this tactic developed countries were accused of exporting their dirty industries to the developing *South* instead of fighting against pollution and climate change.

Consequently, the matrix of chicken game in climate negotiations would look like in Table 13. As it appears, in a period that tempeture rises putting our planet into real danger, countries will eventually have to cooperate reducing their GHG emissions otherwise global warming will risk the disappearance of the humankind (crash). In the strongest position is whoever has the lowest costs (investment in R&D) or the biggest financial reserves, which could compensate for the increased price of carbon due to the internalization of the negative externality of pollution. But the problem is that countries which abate first (*Maxi-min strategy*) lose their competitive advantage and subsequently their revenues that would support their economic growth and their leadership in geopolitical competition to some other countries that continue polluting and as a result they become the pollution reducer of last resort i.e. the one the world expects to swerve first when the planet is in danger. The reduction of one's own options can be a good strategy to win this game. This tactic is *"for one party to signal their intentions convincingly (credible, effective, and temporarily sustainable threat) before the game begins to ostentatiously disable the opponent's steering wheel compelling him to swerve"*[438]and was used in squeeze strategy in favour of a country's economic growth like in the case of US'withdrawal from the Paris Agreement in 2017 (*"Trump effect"* [439]*)*. In a dynamic environment, if the market is contested by a new player, let's say a developing country with lax environmental regulations (*pollution haven*) it is rational for the rich developed country to continue polluting enforcing a downward-pressure on cabon-intensive

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436 (DeCanio & Fremstad, 2013)
437 (Chavez-Angeles, 2016)
438 (Rapoport & Chammah, 1966)
439 (Curtin , 2018)

products'prices in order to not lose its competitiveness (*carbon leakage*), despite long-term losses concerning the environmental degradation. In the case f the EU ETS this strategy was applied through the allocation of emissions rights for free to the sectors at risk of carbon leakage according to the prinsciple of grandfathering. Because of this tactic the whole shceme was accused of ineffectiveness as it ended up perpetuating pollution.

Table 13: The problem of Climate Change mitigation as a game of chichen

		Developing Countries (South)	
		Swerve - Cooperate - Abate (GHG emissions reduction Maxi-min Strategy)	**Straight - Defect - Squeeze - Pollute (max GDP Strategy)**
Developed Countries (North)	**Swerve - Cooperate - Abate (GHG emissions reduction Maxi –min Strategy)**	**TIE,TIE** Salvation of the planet	LOSE,WIN Carbon leakage vs Competitive advantage
	Straight - Defect - Squeeze - Pollute (max GDP Strategy)	WIN,LOSE Competitive advantage vs Carbon Leakage	CRASH Global warming

Source: based on Stephen J.DeCanio's and Anders Fremstad's assumptions in their paper "Game theory and climate diplomacy" in 2013 in Ecological Economics, ed.85, pp. 177-187, available at: https://www.sciencedirect.com/science/article/pii/S0921800911001698,https://eclass.gunet.gr/modules/document/file.php/LABGU362/Game%20theory%20and%20climate%20diplomacy%202013.pdf

5. *International agreement: Prisoner's Dilemma transformation into Coordination Game.*

According to Manuel Chavez-Angeles's research, in the pre-Kyoto Protocol's world, without any agreement on emissions reduction and a business as usual scenario leading to a constant rate of anthropogenic CO2 emissions, models reported a linear increase in climate change's key variables. Precisely, CO2 was increasing in the atmosphere so as atmosphere temperature did. Using basic models he obtained different scenarios depending on the payments from cooperation and defection. Then he concluded that when payment from cooperation is lower to the payment from defection, there is a constant fall in cooperation causing increases in CO2 emissions and in atmosphere's temperature (Prisoner's Dilemma scenario where carbon saving technologies are not implemented) whereas when payment from cooperation is higher than payment from defection there is an increase in cooperation causing CO2 emissions and atmosphere temperature decreases so as high investments in carbon saving technologies. To his assumptions the impact of international negotiations on climate change is significant[440]. However he noted that in a more realistic world climate negotiations and apparent cooperation do not transform immediately in sound policies due to errors in perception or implementation that can lead to serious conflict[441]. Citing Robert Axelrod's assumption[442] he conceded that *"the echo of one mistake could go on indefinitely causing more mistakes so players would oscillate among different combinations of choices and would never be able to reestablish a sustained pattern of mutual cooperation"*[443].

[440] (Chavez-Angeles, 2016)
[441] (Chavez-Angeles, 2016)
[442] (Axelrod , 1997)
[443] (Chavez-Angeles, 2016)

According to Richard Mc Adams's definition *"an equilibrium refers to a Nash equilibrium, which is the central solution concept in game theory, based on the principle that the combination of strategies that players are likely to choose is one in which no player could do better by choosing a different strategy given the ones the others choose"* [444]. It is established by asking if either player has an incentive to deviate from it. At such a point, no one wants to switch strategies. As he argued, single equilibrium games provide a tidy and definitive prediction of the behavioral outcome. One can therefore ignore culture and history because, once factored into the payoffs, their influence is fully exhausted. When played just once, the Prisoners' Dilemma is one of the few games with a single equilibrium. There is a strong temptation to describe a situation as a Prisoners' Dilemma because it renders the problem amenable to an uncontroversial legal solution (unique normative feature). By contrast, coordination games have multiple equilibria and therefore their payoffs alone do not determine the behavioral outcome. As he admitted, if the payoffs do not determine a unique equilibrium, individuals with the same payoffs but different cultural identities may play the game differently. In such cases, history and culture may affect behavior independent of-and in addition to-their effect on payoffs and any prediction is messy[445].

As Stephen De Canio and Anders Fremstad supported in their paper, in the Chicken game, although one party's playing *Maxi-min* could be exploited by the other, only if all parties were playing their *Maxi-min* strategies, climate negortiations could lead to mutual Abatement whereas in both the PD and the Coordination Game, where the least-preferred outcome for either party is if it abates while the other pollutes, it would be possible that early action to abate emissions will confer an advantage in the development of clean energy technologies. The most serious difficulties in reaching a global climate protection agreement arise if one of the major countries (the ones whose emissions alone are enough to produce dangerous anthropogenic interference with the climate) ranks highest the outcome in which it pollutes while the rest of the world abates. In this case both the *Nash equilibrium* and the *Maxi-min equilibrium* risk climate catastrophe. Finally they admitted that in the Coordination Game, unilateral adoption of the Abate strategy by one of the major countries or blocs may increase the incentive for others to abate or be a signal to others that moving to the (Abate, Abate) Nash equilibrium would be beneficial for all. Nevertheless they warn that if one of the Great Powers or set of GPs held as its highest goal the short-run maximization of its relative power, domestic abatement measures by the others would be in vain. Business as usual by either the US or China and India or even EU would threaten climate stability no matter what actions are taken by any one country or subset of countries[446].

Furthermore they claimed that low-carbon energy has to be a component of sustainable development for poor countries currently seeking to improve their standards of living. In this context they wondered what benefits a climate treaty could offer rich countries in exchange for dramatically cutting their emissions and providing investment funds and technology to poor countries. Citing Barrett's proposals[447] they predicted exclusionary benefits to joint work on technological innovation and the setting of standards. As they stated considering that larger groups of countries make more technological discoveries, and offer the possibility of more valuable alliances: *"if a critical mass of participating countries agreed to invest together in R&D and share the successes exclusively among participants, the benefits of*

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444 (McAdams, 2009)
445 (McAdams, 2009)
446 (DeCanio & Fremstad, 2013)
447 (Barrett, 2003)

participation may outweigh the costs for each individual country" [448].They also suggested trade advantages extended to participants, and/or trade sanctions imposed on non-participants treated as rogue states. Finally, they assumed that investments in advanced non-fossil energy technologies in developing countries could be a means by which Great Powers would expand their influence. Given the imperatives of economic development and poverty reduction, transfers from rich countries to poor countries, in the form of low-carbon or zero-carbon energy supply technologies, would be also essential to induce the poorest developing countries to participate. For them such investments could be part of a relatively healthy form of Great Power competition, because diffusion of the technologies could contribute to the spread of a powerful nation's influence without resort to coercion or war. However, a unilateral approach to emissions reduction may not be the best strategy for any country[449].

Stephen De Canio and Anders Fremstad in their paper cited also Bryan Bruns's notes on how *"swaps"* defined as switching the ranks of outcomes for a player (let's say a government), could transform one climate-relevant conflict game into another no conflict one[450]. As they claimed this would be possible through greater understanding of the science - which fortunately is universal - that underlies assessment of the seriousness of the long-term risks of climate change, or even through side payments or negative incentives such as trade sanctions of effective size. Feasible instruments leading to a cooperative solution would induce the necessary investments in clean energy and efficient end-use technologies while simultaneously promoting economic growth in the poorest developing countries. Great understanding of the climate risks could eventually bring all major governments to realize that Abatement is in their long-run interest. Diplomacy could also work to create incentives that will push the governments towards cooperation[451]. Policymakers should also consider the possibility that market-based approaches like harmonized taxes or restraints on carbon are effective tools for coordinating policies and slowing global warming.

[448] (DeCanio & Fremstad, 2013)
[449] (DeCanio & Fremstad, 2013)
[450] (Bruns, 2010)
[451] (DeCanio & Fremstad, 2013)

VII. The corrective solution of Border Carbon Adjustments (BCA)

The mainstream economics literature shows that the failure to put a price on global emissions is inefficient. Free trade can reduce welfare when there is a global externality that has not been internalized. Chichilnisky showed that trade between a region with well-defined property rights and a region with ill-defined property rights increases global pollution and reduces welfare because the former overconsumes goods, produced with dirty technologies[452]. In relatively simple models, the first-best solution is free trade, coupled with a common global carbon price, which would achieve the maximum welfare with the external costs of carbon emissions internalized, a precondition for Coase's efficient solution to take place[453]. However, the latter requires a self-enforcing global agreement that has so far failed to materialise, because there is no international court to enforce property rights over the atmosphere. Rather, any outcome on the allocation of rights to use the atmosphere will be necessarily determined by political negotiation[454].

The lack of progress on an international climate change agreement shows no sign of being resolved any time soon. At the heart of the Kyoto Protocol's failure to address climate change is the fact that fast growing developing countries such as China and India didn’t have binding quantitative emissions targets. This was one of the reasons for the US’s refusal to ratify the Kyoto Protocol. What makes matters worse is that these countries are the source of the bulk of the emissions growth, based primarily on an increasing coal burn[455]. As a result, global emissions have not been dented since 1990, and globally coal has continued to increase both in relative share and in absolute amount. The only event that has made any substantial difference to global emissions is the economic crisis and the associated reduction in economic growth, but even this has had only a limited effect[456]. Despite the growing emergency of serious climate change impacts, international negotiations are blocked because of strong free-riding incentives[457], lobbying from energy intensive sectors and equity concerns about the North-South burden sharing. Climate policies will remain sub-global in the years to come, and unilateral or regional policies, including regulations, subsidies, carbon taxes and carbon markets, have emerged as some industrialized countries decided unilaterally to reduce their emissions. The top-down global Kyoto approach is shifting towards a bottom-up architecture with different CO2 prices[458]. The result of efforts to address climate change has been the emergence of a *two-speed carbon world,* some (mainly Europe) with a variety of carbon prices, but most without. This creates clear and unambiguous price distortions to trade, and it is reinforced by multiple differences in energy taxes, which are high in Europe, lower in the US and negative (in the form of fossil fuel subsidies) in the Middle East, Russia and elsewhere[459].

As it is argued, in the context of growing globalisation, the fierce competition to attract FDIs or the threat of industrial relocation leads to a *“regulatory chill”* or even a *“race-to-the bottom”*, depending on the willingness of countries to downgrade environmental standards. Indeed, the fear of carbon leakage and loss of competitiveness in energy-intensive

[452] (Chichilnisky , 1994)
[453] (Coase, 1960)
[454] (Helm, et al., 2012)
[455] (Helm, et al., 2012)
[456] (Helm, et al., 2012)
[457] (Carraro & Siniscalco, 1993)
[458] (Weischer, et al., 2012)
[459] (Helm, et al., 2012)

industries are the main arguments against ambitious climate policies in industrialized countries. Modest mitigation targets have gone hand in hand with policy packages intended to protect sectors at risk of carbon leakage (mainly cement, iron and steel, aluminium and oil refineries). These trade distortions have themselves had a negative feedback on climate policy.[460] In the case of the EU ETS, the biggest carbon pricing experiment so far, the policy of choice to address trade and competitiveness concerns, as a way out of the economic crisis, through an over-allocation of permits to EITE industries for free, has created further distortions and finally led to a crash in carbon price. This policy constituted an exemption or even an implicit subsidy for such sectors opening the way for rent-seeking activity, large-scale lobbying and generated major inefficiencies. The proportion of permits being auctioned has since been increased but the risk of carbon leakage and loss of competitiveness couldn't be confronted in that way[461].

Different policy options to face these issues are then examined with an emphasis on Border Carbon Adjustments (BCA). BCAs consist of reducing the carbon price differentials of goods traded between countries, inspired by measures in place for Value Added Tax. They are based on theoretical grounds to improve the cost-efficiency of subglobal climate policies[462][463]. BCAs were considered a way to *"punish"* the US for free-riding the Kyoto Protocol[464]. Later, the US incorporated BCAs, the best response to trade distortions, in the Waxman-Markey amendment, in order to resolve its trade concerns aiming mainly at Chinese products[465]. According to ex ante modelling studies, properly implemented, BCAs can reduce leakage through the competitiveness channel in a cost-effective way by around 10 percentage points but not through the international fossil fuel price channel (Section V1A&B)[466]. They include three types of measures: border taxes (as tariffs on imports and, less commonly, rebates on exports), mandatory emissions allowance purchase by importers and embedded carbon product standards[467]. In every case, their objective is to extend a domestic carbon pricing scheme to traded goods[468].

BCAs are extremely controversial measures as, in spite of their effectiveness to protect competitiveness, they are accused of shifting a part of the mitigation burden of abatement costs from abating to non-abating developing countries[469]. According to Dröge's assumption, BCAs if implemented, might conflict with the *Principle of Common but Differentiated Responsibilities* of the UNFCCC and as a result developing countries could publically condemn them as *"green protectionism"* or *"ecoimperialism"*[470] disguised as green policy[471]. For instance, China strongly opposes BCA and claims that energy-intensive exports are already taxed[472]. In addition, their impact on international negotiations is unclear: they could encourage third countries to join the abating coalition or by creating international

[460] (Ederington, et al., 2003)
[461] (Helm, et al., 2012)
[462] (Markusen, 1975)
[463] (Hoel, 1996)
[464] (Hontelez, 2007)
[465] (Van Asselt & Brewer, 2010)
[466] (Branger & Quirion, 2014/02/01, pp. 53-71)
[467] (Wooders, et al., 2009)
[468] (Helm, et al., 2012)
[469] (Branger & Quirion, 2014/02/01, pp. 53-71)
[470] (Dröge, 2011)
[471] (Evenett & Whalley, 2009)
[472] (Voituriez & Xin , 2011)

friction they could lead to tit-for-tat trade retaliations[473] and trigger a trade war based on *"green protectionism"* suspicions[474]. BCAs' credibility requires that countries adopting the BCAs have an incentive to retain them, i.e. are not subject to any credible threat of retaliation[475]. However, some argued that the *"carrot"* of technology transfer would be more effective than the *"stick"* of BCA[476]. Furthermore, the benefits of internal improvements of emission trading systems within the abating coalition like linking markets and extending sectoral coverage could outweigh those of BCAs[477].

On the other hand, Paul Krugman, one among the advocates of BCA, argues that BCAs are *"a matter of levelling the playing field, not protectionism"*[478]. In addition, Dieter Helm, Cameron Hepburn and Giovanni Ruta in their paper in favour of BCAs. argued that despite the conventional view of BCAs as a green trade barrier, a form of *"murky protectionism"*, it is the *absence* of a carbon price, which effectively comprises an implicit subsidy to dirtier production in non-regulated markets and which is a market imperfection, rather than a BCA (the correction of a market failure) that should be regarded as the distortion. On the contrary BCAs correct a distortion (by pricing the negative externality of pollution in imports), but because they reduce trade it might be thought that they create another distortion. However, as they admit, increased welfare is the objective and not trade itself, as it can only be guaranteed to improve welfare when prices reflect the correct social costs. Respectively, incorrect prices can lead to sub-optimally high levels of trade but also to high levels of pollution reducing welfare. Climate change involves a global negative externality and the failure to internalise the negative (global) impacts of carbon emissions represent a *de facto* subsidy to the costs of production[479]. Furthermore, as Stiglitz argued countries should prohibit the importation of goods produced using energy intensive technologies, or, at the very least, impose a high tax on them, to offset the subsidy that those goods currently are receiving[480].On the contrary, according to D.Helm, C.Hepburn and G.Ruta's assumptions, unilateral carbon pricing schemes, without associated BCAs, if they simply shift production to less regulated markets, will suffer the loss of their price competitiveness, a phenomenon known as *carbon leakage*[481].

Carbon leakage highlights a fundamental problem with Kyoto, which is based upon carbon production, not carbon consumption. As a result the Kyoto-capped countries can reduce their measured production of emissions by reducing production in the carbon intensive sectors, and then import back the carbon intensive goods. As it is admitted, the potential carbon leakage problem arises because we currently have a multispeed carbon world, some with carbon prices, most without. This creates a trade distortion and undermines the incentives to introduce and increase unilateral carbon prices[482]. This major failure of Kyoto was highlighted through a lot of studies. Firstly Druckman et al. showed that any achievement in reducing production-based emissions disappears when a consumption-based perspective is taken[483] while Helm et al. indicated that between 1990 and 2005 UK emissions

[473] (Indian Institute of Foreign Trade, 2010)
[474] (Branger & Quirion, 2014/02/01, pp. 53-71)
[475] (Helm, et al., 2012)
[476] (Weber & Glen , 2009)
[477] (Lanzi, et al., 2012)
[478] (Krugman, 2009)
[479] (Helm, et al., 2012)
[480] (Stiglitz, 2006)
[481] (Helm, et al., 2012)
[482] (Helm, et al., 2012)
[483] (Druckman , et al., 2008)

on a consumption basis rose by 19%[484]. In addition, Atkinson et al. showed the main net exporters of embodied emissions (to which the authors refer as 'virtual carbon'), are China, Russia and other middle income countries, while the main net importers are the EU, USA and Japan[485]. The answer is to impose BCAs so that carbon produced domestically is treated on the same basis as carbon embedded in imports, so the carbon content is independent of the geography of its production. Introducing BCAs corrects the major trade distortion caused by those countries that do not price carbon subsidising dirty production and gaining a trade advantage. Furthermore, if regions with domestic carbon pricing schemes, such as the EU, started applying BCAs (let's say an *'effective tariff'* rate of 9.2% of the value of exports) pricing consumption rather than production, this would have a major impact on large fossil fuel-based exporters such as China. Precisely, China's exports of CO2 to the EU15 are 6.2% of the total produced while the 'exports' of CO2 to both the EU15 and the US amount to 13.1% of the total produced, and as a result it is extremely exposed to a BCA that the EU may impose. As other countries like China will follow suit with their own carbon export adjustments or broader carbon prices, the impetus for a *'sectoral agreement'* will increase. In that way BCAs provide a mechanism to enhance efficiency while at the same time they lessen the incentives of free-riding and strengthen incentives for the countries without carbon prices to introduce them providing a pragmatic way of gradually expanding the *"coalition of the willing"* around the world, without having to wait for a top-down global treaty. Thus BCAs both remove distortions and encourage convergence towards a global carbon price[486].

Finally, the most controversial aspect of this measure is its compatibility with the *World Trade Organization* (WTO). The General Agreement on Tariffs and Trade (GATT) was established in 1947 in a world without climate change on the international agenda, so its rules were not drafted to address climate policies, making the interpretation of legal texts particularly difficult. The WTO was created in 1995, as a successor of GATT, in order to implement trade liberalization by prohibiting unjustified protection and discrimination. The legal principle underlying all WTO regulation is the non-discrimination principle, divided into two key principles: the National Treatment principle (NT, article I) which prohibits country A to discriminate against country B or country C products over its own goods and the Most Favoured Nation principle (MFN, article III), which forbids country A to discriminate against country B goods over country C goods. BCA could then respect the general regime of WTO providing they respect these core principles. Assessing the WTO consistency of BCA according to its specific features and precisely the extent to which countries can restrict imports of environmental damaging goods through them divides legal experts and has led to extensive literature on the subject. International institutions state that free trade has a role to play in climate policies by promoting clean technology transfer and suppressing murky subventions to dirty sectors, but remain ambiguous concerning the legality of BCA[487]. Legal acceptability and political feasibility of BCA would depend on the specific designs of such measures. However, a second-best option could be to fall under the GATT exception regime (article XX). Indeed, providing they are not used as a means of arbitrary discrimination (article XX chapeau, which is a lighter version of art. III), measures that do not find justification under the general regime can still be implemented if they follow one of the eight subparagraphs of art. XX. In the case of BCA, it could be Art. XX (b) or (g),

[484] (Helm, et al., 2007)
[485] (Atkinson , et al., 2011)
[486] (Helm, et al., 2012)
[487] (World Bank, UNEP, 2007)

if BCA are considered *"necessary to protect human, animal, or plant health of life" or "relating to the conservation of natural resources"*[488].

In short, a party like the EU has a strong incentive to introduce BCAs to complement their near-unilateral carbon prices. Once the EU does so, the rest of the world has a strong incentive to respond with carbon export adjustments, or potentially even a national carbon price, rather than starting a trade war. This is precisely what is currently underway, with aviation. The incorporation of international aviation into the EUETS on January 2012 has served as a *de facto BCA*, as the entire emissions from any flight that arrives or departs the EU are captured, irrespective of whether the emissions occur over other countries' airspace. While 85% of the permits were allocated to airlines free of charge, polluting airlines have now to buy additional EUAs to cover their liability. The policy has the effect of imposing a carbon price on all flights *to and from* Europe and thus operates in a similar fashion to a BCA. The policy has, not surprisingly, been vigorously challenged by a large number of countries (around 20) including India, the US and China. A failed pre-emptive attempt by India to table in front of the U.N. a resolution banning climate-related protectionist measures like BCAs at the Durban conference in September 2011 signals the battles that may be to come. Rich countries commented that the issue should be addressed at the WTO rather than UNFCCC talks. The first hurdle is that border adjustments *prima facie* could be considered to breach "non-discrimination" requirements on the grounds that imported goods are "like" domestically produced goods, notwithstanding their greater embodied emissions. However, compliance with WTO rules rests on the GATT's *"general exceptions"*, as above outlined. Finally, when a case was launched in the European Court of Justice by US airlines, it held that the inclusion of aviation in the EUETS did not infringe the sovereignty of other states and is compatible with international law[489].

To conclude, according to D.Helm, C.Hepburn and G.Ruta's assumptions, BCAs have the potential to be a game changer in supporting, or potentially providing a substitute for the international climate negotiations. These international negotiations have so far failed to deliver any more than *"roadmaps for agreement"*. As they support in their paper, *"there are now at least three ways to proceed for countries or regions aspiring to leadership, such as the EU:*

1. *Maintain the current, unilateral policy regime, risking carbon leakage until a new global deal is implemented in 2020, and accepting major economic inefficiencies and increases in global emissions consistent with likely temperature increases above 2oC;*
2. *Accept that the current regime leaves little chance of achieving the 2oC temperature target, and extend exemptions from domestic carbon prices (e.g. the free allocations in the EUETS and ACPM) and other implicit subsidies to the export sector to protect domestic industry as the world warms; or*
3. *Apply border carbon adjustments to countries that have not taken "equivalent measures" to internalise the carbon externality"*[490].

According to their proposition, an effective climate 'deal' could arise indirectly from the threat of unilateral trade policies. This could come about, using a simple political game theory model, where the *sub-game perfect Nash equilibrium (SPNE)* is a world with increasing BCAs. Properly crafted BCAs could help reduce trade distortions, limit the competiveness effects, and help build a broader coalition of interests supporting more global

488 (Alexeeva-Talebi , et al., 2012)
489 (Helm, et al., 2012)
490 (Helm, et al., 2012)

actions. BCAs are a strategically and political rational choice, in that they take into account what the other parties would do in response. While there is undoubtedly some risk to the trading regime, provided the (economically sound) rationale for BCAs is explained carefully and in good faith, it seems likely that the risks are low. Furthermore, arguably the risks to humanity from catastrophic climate change have both higher probability of occurring and greater impact should they occur, than the risks to the trading regime from BCAs. Their paper's novelty consisted in the application of game theory to the issue of BCAs with two assumptions justifing the use of a *sequential move*, or *dynamic*, game of full information. First, that parties involved do not agree simultaneously on a course of action (as in a multilateral environmental agreement) but move sequentially, that is, BCAs are unilateral actions. In fact, the failure to agree on a global course of action on climate change, is the starting point of the paper. Second, it was assumed that each party knows the extent to which their actions impose costs on other parties. The relevant equilibrium concept is the one of subgame perfection[491].

In their game-theoretic analysis, the description of the trade game illustrates how the world is able to sustain equilibrium with free trade. They conclude that in the absence of a coordination mechanism, countries would *de facto* move simultaneously as in a *"prisoner's dilemma"* type of game. In such case the *Nash equilibrium* would then be to mutually impose trade restrictions. Trade agreements transform the simultaneous game into a dynamic game through the working of the institutional mechanisms they set up. With the WTO mechanism in place, if one of the two countries moves first and does so against trade rules, the second one can wait to obtain the 'right' to move and retaliate. This credible threat is enough to prevent the first country imposing a trade restriction. The inclusion of aviation is analogous to imposing a carbon price with a BCA, because the carbon price applies to any flight landing or departing in the EU. ROW will find it optimal to respond to this EU *de facto BCA* with its own carbon export adjustment. This is economically rational, in that it allows the ROW to extract the surplus from carbon pricing before the EU does. If the ROW's optimal response to a BCA is to respond with a carbon export adjustment, it will be in the EU's interests to introduce a BCA in the first place, rather than "do nothing", and the upper-right branch of the game represents the *Sub-game perfect Nash equilibrium (SPNE)*. On the other hand, practical objections are capable of being addressed, in line with what the political game theory analysis above suggests. If the use of BCAs would actually cause the entire global trade regime to collapse, and result in countries engaging in *self-harming retaliatory protectionism*, then the underlying trade game is not as above described and the optimal strategy on BCAs is different. BCAs' credibility requires that countries adopting the BCAs have an incentive to retain them, i.e. are not subject to any credible threat of retaliation. The above simple model captures the essence of the strategic interaction[492].

According to Ederington, Levinson and Minier's assumptions on purely economic grounds and from the point of view of the abating coalition, economic analysis favours the implementation of BCA, but from a legal and diplomatic point of view, the situation is much less clear-cut. Their proposition describes a BCA based on *Best Available Technology (BAT) benchmarks*, with revenues earmarked for climate-related projects in developing countries, as the best solution. A fallback option for them would be to distribute free allowances in proportion to current output of EITE industries (*output-based allocation*). Although less cost-effective, it is proposed in their paper as an acceptable compromise between efficiency

[491] (Helm, et al., 2012)
[492] (Helm, et al., 2012)

and feasibility. However, just as free allowances based on historic or capacities, the option implemented in the EU ETS, it could generate massive lobbying and competitive distortions since every industry tries to receive as much allowances as possible[493].

In this context, permit conditions for each sector must be set and revised, based on the respective BAT Conclusions. Within these documents, pursuant to Directive 2008/1/EC, the *Best Available Techniques (BAT)* and the associated *BAT Emission Levels (BAT-AELs)* are defined for each particular industrial sector as *"the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole"*[494]. Industrial installations must use the BAT, which are *"developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions"* (Article 3(10)(b) IED). In specific cases, however, an assessment may indicate that, although the installation could stay within the level of emissions as set by the BAT, this would lead to increased costs that outperform the potential environmental benefits. In such cases, a certain amount of flexibility is thus provided for, allowing licensing authorities to deviate from BAT requirements. Flexibility must be a central piece of the policy package, which could mean allowing third countries national *"comparable action"* instead of systematic border carbon pricing[495]

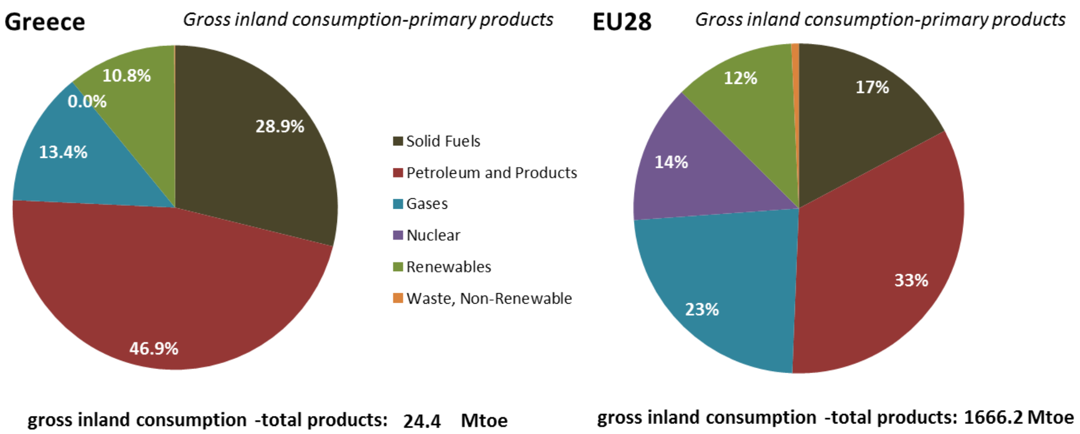
WTO and UNFCCC share the unpleasant fact of being bogged down in international negotiations blockage and a clash between climate and trade regimes would be detrimental to both global trade and climate agreements. If BCAs are not likely to be implemented in the following years, they will undoubtedly be considered more and more, as abatement targets gaps are growing among countries. A weak version of BCA, based on *Best Available Technologies benchmarks* with the handing back of revenues, would seem the most preferable option, offering less vulnerability to a potential WTO dispute and giving certain compensations to other countries[496].

[493] (Ederington, et al., 2003)
[494] (climatepolicyinfohub.eu)
[495] (Low, et al., 2011)
[496] (Low, et al., 2011)

VIII. The case of Greece

The energy mix of Greece shows some differences compared to the EU28 average (Figure 15), i.e. by a higher use of petroleum and solid fuels, while a lower use of gas and no nuclear. Compared to 1995, the share of petroleum products and solid fuels in gross inland energy consumption decreased (by 11 and 5 percentage points respectively), while the share of gases and – to a lesser extent – renewable energy increased (by 13 and 4 percentage points respectively)[497].

Figure 15: Gross inland energy consumption in 2013



Source: European Commission, based on EUROSTAT, available at:
https://eurlex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52015SC0226

As it appears in the Table 14, through the whole scheme of the economy's decarbonisation, Greece has decreased its emissions by 35% between 2005 and 2014. According to the latest projections, Greece is on track to reach its greenhouse gas emission reduction target for 2020, with approximately a 27% margin as compared to 2005. Behind this significant share of the decrease in GHG emissions is, besides the economic crisis, a significant shift in Greece's energy mix from lignite towards gas and renewable energy. With a renewable energy share of 15% in 2013(Table 15) and an energy savings share of 23,5% in primary energy consumption in 2016 (Table 16), Greece is on track to reach its targets in 2020 (18% and 24,7% correspondingly), but efforts should be strengthened ahead of 2020. The lack of predictability and transparency of renewable support schemes might jeopardise the development of this important sector for energy security and growth. As a result of the energy mix that also relies on locally available lignite resources, the carbon intensity of the Greek economy is about 70% higher than the EU average (see Table 17). In Greece, the energy sector contributes to half of the total emissions, a share that is well above the EU average. In addition, the carbon intensity of energy use is one of the highest in the EU (3.2 compared to 2.1 EU average 1,000 tonnes/ 1,000 TOE). Hopefully, in 2014, all the revenues from the auctioning of ETS allowances amounted to EUR 131.1 million were used or planned to be used for energy and climate-related purposes (mainly in the renewables sector)[498].

Table 14: Greenhouse gas emissions (index 1990=100)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	100	98.26	95.28	93.6	93.15	94.18	96.16	94.47	93.79	92.04	92.27	93.25	92.42	93.96
GR	100	99.74	101.01	100.76	103.83	105.89	108.76	113.33	118.75	119.21	122.06	122.89	122.89	127.1

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
EU 28	94.09	93.56	93.44	92.68	90.64	83.98	85.83	83.13	82	80.36	77.41	77.99	77.64	80
GR	127.83	131.54	128.03	130.66	127.53	120.46	114.56	111.85	108.42	99.42	96.54	93	89.69	

Source: European environment agency (EEA), 17Aug 2018, available at:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_30

497 (European Commission, 2015)
498 (European Commission, 2015)

Table 15: Share of renewable energy in gross final energy consumption

%	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
EU 28	8.5	9.0	9.5	10.5	11.1	12.4	12.9	13.2	14.4	15.2	16.1	16.7	17.0	20
GR	6.9	7.0	7.2	8.2	8.0	8.5	9.8	10.9	13.5	15.0	15.3	15.3	15.2	18

Source: Eurostat, 17Aug 2018, available at:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=t2020_31

Table 16: Energy efficiency

Primary energy consumption (index 2005=100)

MTOE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	1,570.0	1,572.9	1,538.7	1,546.9	1,531.3	1,567.2	1,627.3	1,608.7	1,620.1	1,609.0	1,617.6	1,658.0	1,654.8	1,691.8
GR	21.6	22.0	22.7	22.5	23.3	23.4	24.0	25.0	26.2	26.4	27.6	28.4	28.8	29.5

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TARGET
	1,707.5	1,713.3	1,722.5	1,694.0	1,693.0	1,598.9	1,657.5	1,595.4	1,586.1	1,571.2	1,508.6	1,531.9	1,542.7	1,483
	30.0	30.6	30.7	30.7	30.9	29.6	27.6	26.9	26.8	23.6	23.7	23.7	23.5	24.7

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	91.6	91.8	89.8	90.3	89.4	91.5	95.0	93.9	94.6	93.9	94.4	96.8	96.6	98.7
GR	70.6	71.7	73.9	73.3	76.0	76.3	78.4	81.5	85.4	86.0	90.0	92.7	94.1	96.4

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	99.7	100.0	100.5	98.9	98.8	93.3	96.7	93.1	92.6	91.7	88.1	89.4	90.0
	97.8	100.0	100.1	100.1	100.8	96.4	90.1	87.8	87.5	77.0	77.2	77.5	76.8

Final Energy Consumption

MTOE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU 28	1084,6	1091,1	1065,9	1069,8	1064,0	1082,6	1130,7	1119,2	1127,5	1127,6	1132,7	1156,5	1145,0	1176,6
GR	14,7	15,0	15,1	15,1	15,4	15,8	16,9	17,4	18,3	18,2	18,7	19,3	19,6	20,7

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	1188,6	1192,7	1194,4	1173,6	1179,5	1115,8	1163,2	1109,2	1108,5	1108,2	1063,1	1086,2	1107,7
	20,5	21,0	21,6	22,1	21,4	20,5	19,0	18,9	17,0	15,3	15,5	16,5	16,7

Source: Aug 20, 2018 - 8, Energy Country datasheets: EU28 countries, EUROSTAT electricity and gas markets survey (update May 2018), European Commission,
https://ec.europa.eu/energy/sites/ener/files/documents/countrydatasheets_august2018.xlsx

Table 17: Indicators of GHG emissions in Greece & EU

GHG Emissions	**Greece**	**EU**
EU ETS auctioning revenues in 2014(EUR millions)	131.1	3205
Share of ETS emissions in 2013	56%	42%
GHG emissions/capita in 2013 (tCO_2equivalent)	9,6	8.5
Carbon intensity of economy in 2013 (tCO_2equivalent/EUR millions)	568	328

Source: European Commission based on EEA(*) Sectoral breakdown for 2013 data not yet available.

1. *Grandfathering*

Industry sectors, in Greece as in the whole Europe, vigorously resist in the strengthening of the ETS mechanism, despite the fact that they have already taken on support through free allocation of emission allowances. According to a WWF policy document in cooperation with Sandbag, for Greece, the number of rights allocated to industries exceeded the actual emissions needs by 21.6 million, while the value of this surplus was estimated at around € 335 million for an average purchase price of € 15.50 (2008-2011), as calculated by Sandbag[499]. Unused pollution permits were either *'re-released'* to the market for revenue or 'stored' for use in the third phase of EU ETS (2013-2020). What's more excessive rights they had through the Kyoto market-based mechanisms (CERs and ERUs described in section IV3Aiii), further increased the total amount of unallocated rights. As EU ETS rights had a steadily greater value than the corresponding units in the international market, companies

[499] data used from Blue Next exchange www.bluenext.eu (last access: June 2012)

can make further profits from the difference in their price. Thanks to these free rights companies have been relieved of any compliance cost due to the emission reduction mechanism. Indeed, many of them have resold the rights that they didn't need, earning substantial revenues that facilitated their survival in times of crisis. Surplus allowances were in some cases so large that their holders have been shielded for the subsequent periods of the ETS[500]. The gains of Greek industry from the second trading period, as they were estimated by WWF & Sandbag are listed in the following Table:

Table 18: Estimated value of ETS rights for the 10 largest surplus companies

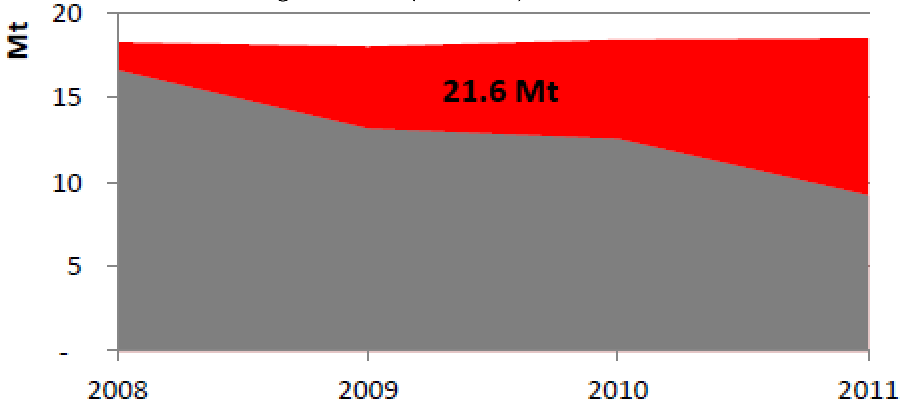
COMPANY	Surplus of ETS rights	Surplus value (€ 15,50 per share)
Lafarge - Heracles Group	10.241.882	€ 158.749.171
SA TITAN Cements	4.222.282	€ 65.445.371
Γ.Μ.Α.Α.Ε. LARCO	641.972	€ 9.950.566
Hellenic Petroleum SA	639.311	€ 9.909.321
Hellenic Sugar Industry SA	618.254	€ 9.582.937
Halyps Building Materials SA - Italcementi Group	568.369	€ 8.809.720
CaO Hellas ABEE	554.855	€ 8.600.253
SIDENOR SA	484.825	€ 7.514.788
KOTHALI Group	402.063	€ 6.231.977
Hellenic Steelmaking	307.840	€ 4.771.520
TOTAL	**18.681.653**	**€ 289.565.622**

Source: WWF Ελλάς & Sandbag, Φεβρουάριος 2013, Η εφαρμογή του Συστήματος Εμπορίας Δικαιωμάτων στην Ελλάδα, www.wwf.gr/images/pdfs/ETS_February2013.pdf

Mr Panagiotis Koronaios, lawyer employed in the legal department of Titan Cement Company S.A. in Greece, in an interview conducted by me especially for the needs of my research has admitted that in the period of decreased economic activity during the economic crisis, the surplus of EUAs allocated for free to the company in the *"bull market"* period, has been sold to other emitters while the earnings were used in the company's survival without the need of any dismissals[501]. The below figure (Figure 16) represents the allocation of free allowances from the Greek state to the country's industries, in the period between 2008 and 2011 compared to the actual emissions of the respective units. It is evident that the industries have received more rights than their actual emission levels, while the surplus was growing every year, in line with declining production[502].

[500] (WWF Ελλάς & Sandbag, 2013)
[501] (Koronaios, 2019)
[502] (WWF Ελλάς & Sandbag, 2013)

Figure 16: Greek manufacturing industries (CITL 2-9) 2008-2011



Source: WWF Ελλάς & Sandbag, Φεβρουάριος 2013, Η εφαρμογή του Συστήματος Εμπορίας Δικαιωμάτων στην Ελλάδα, www.wwf.gr/images/pdfs/ETS_February2013.pdf, orig.source European Union Tracking System through the European Environment Agency

The vast majority of surpluses was concentrated in a few enterprises. The survey of WWF Hellas to the Sandbag database and other published data showed that 18.7 million surplus free allowances had been distributed to only 10 companies, accounting for 87% of the total surplus of the Greek manufacturing industry. In particular, as cited the pottery industry received 3 times more pollution permits than was needed (278%), while the iron and steel industry received nearly twice as many rights as its real needs (187%). As expected from the cross-sector analysis, the sector with the largest over-allocation was the cement and lime industries such as Lafarge - Heracles Group (10.2Mt) and SA TITAN Cements (4.2Mt), which have accumulated a total of 17Mt of excessive rights equivalent to 79% of the Greek industry total surpluses[503].

It is obvious that the participation of Greek companies in the second trading period (2008-2012) has not adversely affected their competitiveness. Rather the opposite: many of them have made unexpected gains from the European pollutant market. Nonetheless, industries are now relying on compliance costs and lack of rights during the third phase of the mechanism (2013-2020) with the optimistic assumption of returning production to 2008 levels to justify their strong resistance to market reform and tightening of the maximum allowable emission limit. Even if Lafarge's production - Heracles Group returns to 2008 levels throughout the third period (up 240% compared to today), unallocated rights are estimated to reach 11.23 by the end of 2020 millions - far higher than today, thus offering a chance to earn even in the fourth trading period after 2020. Similarly, even if SA's operations TITAN cement returns to 2008 levels (273% of current emissions), the company has been shielded against the direct cost of participating in the system for the entire duration of the third period and beyond. In both cases, the accumulated pollution permits remove the companies from any direct cost of participation in the mechanism[504].

This development didn’t apply to the electricity industry, which was found from the outset with a 'deficit' balance of rights. The largest proportion of emissions in the EU ETS is attributable to the power generation industry, the one with the smallest exposure to 'carbon leakage' and with the most affordable emission limiting technologies available. As a result, most EU countries have avoided protecting energy companies and the number of free allowances allocated to them was below their actual emissions. Greece could not be an

[503] (WWF Ελλάς & Sandbag, 2013)
[504] (WWF Ελλάς & Sandbag, 2013)

exception! PPC had to buy 17 million pollution rights to cover its 195Mt of emissions during 2008-2011. Things would have been even worse if this economic downturn had not coincided with the resulting decline in electricity demand during the economic crisis (PPC's emissions in 2011 have dropped by 10% since 2008). Since 2013, European electricity companies are obliged to obtain all the rights they need from the free market. PPC's bought rights were increased from 4% to 100% at once. Although this has been expected for years and in spite of its big size providing all the necessary tools (75% of the total energy produced, ownership of the Greek electricity transmission system and control of 100% of the Greek market), PPC has done too little to reduce compliance costs upgrading and diversifying its energy portfolio. Despite being the first to enter the Greek renewable energy market (through PPC Renewables), the company has made little progress in this area. What's more, instead of proceeding directly to the replacement of its outdated units with alternative clean energy, it gives them an extension of life (Ptolemaida V, see IV6ii).

The price of non-timely PPC adjustment will be high even with the collapse of CO2 prices. Thus, for every kilowatt-hour produced by the company, the extra cost will inevitably be passed on to final consumers. In this context, PPC has suggested to the Regulatory Authority for Energy an increase in charges for all categories of customers (low, medium and high voltage)[505] [506]. Industrial energy consumers have strongly reacted, suggesting that our country should have been excluded from full participation of power generation in the ETS mechanism (EU ETS article 10c derogation, see IV6ii). However, it was argued that in opposition to the 10 eligible countries (Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Lithuania, Poland, Romania, Malta and Latvia) for temporary free allocation of allowances, so that they were given the time to modernize their power infrastructure, the oldest Member States (including Greece) had enough time to upgrade their power generation model and invest in clean technologies and that possible state aid to generators in the form of free allowances would violate European energy market legislation. In any case, the burden on consumers could be mitigated through the use of the significant revenues from the auctioning of allowances in electricity to investments in energy efficiency and RES technologies that would boost the competitiveness of Greek economy while delivering significant environmental benefits through the costs reduction and the creation of jobs in terms of a sustainable development[507].

2. *Lignite model*

Greece needs to seek the fastest possible detoxification from the world's most polluting fossil fuel, especially in the next phase 2021-2030 of the carbon market. Monopoly access and exploitation of lignite deposits by the PPC distorts free competition, which would lead to lower electricity prices that would benefit consumers. The above rationale implies the assumption that lignite would remain the cheaper power generation technology. This assumption was true in the past, and only if no one counts the large external costs (negative externalities) of lignite exploitation. However, it is no longer valid and will certainly not apply in the future. According to Nikos Mantzaris, energy and climate policy expert at WWF Greece, the future of lignite is negatively prescribed for three main reasons. First and foremost, the revision of the EU ETS was designed to lead to a drastic increase in the price of the CO2 emissions rights, which will cause a very heavy burden on the operating cost of PPC's power plants, as lignite plants will not receive free emission allowances. A second

505 (Public Power Corporation, 2012)
506 (Regulatory Authority of Energy, 2012)
507 (WWF Ελλάς & Sandbag, 2013)

major development was the introduction of new stricter emission limits for other pollutants for large combustion plants. These in practice require expensive upgrading projects for the highly polluting lignite units, which in turn lead to an increase in the lignite kilowatt hour price. Thirdly, the strident advancement of technology to clean energy and storage has made them directly competitive with conventional fuels. In support of the above, a recently published study on Greece's Long Term Energy Plan by the National Observatory of Athens and WWF Greece demonstrated that electricity costs will be significantly higher if the country's lignite reliance is prolonged. On the other hand, electricity costs go down under the scenarios that foresee the expansion of renewable energy sources combined with ambitious energy efficiency policies[508].

For decades, Greece has relied on lignite mining and lignite-fired coal plants to power its mainland, while the islands are served primarily by oil. Greece's coal mining activities are centered on domestic lignite resources in the north and south of the country. In 2014, total proven reserves were equivalent to three million tonnes (Mtoe), with total lignite production equivalent to 48 Mtoe[509]. Apart from a small proportion of privately mined lignite, the majority of lignite mining is carried out by the 51% government owned Public Power Corporation (PPC). For the majority of its mainland electricity production, Greece depends on 13 ageing lignite power units, or six lignite plants, which are some of the most polluting stations in Europe[510].

As a Member State of the European Union (EU) and thus part of the G20, Greece has repeated its commitment to phase out fossil fuel subsidies every year since 2009. In 2016, as a continuing EU member and therefore part of the G7, the country called on all nations to end fossil fuel subsidies by 2025. The European Commission (EC) has furthermore repeatedly called on EU Member States to end all environmentally harmful subsidies, including those to fossil fuels, by 2020. It is estimated that the country will have to shut down a large part of its remaining lignite power capacity by 2030 because of ageing plants as well as European Union (EU) pressure from the application of the new ETS Directive and the Industrial Emissions Directive[511]. The Government's prioritization of new coal-fired production capacity has been accompanied by declining budget and regulatory support for solar PV and wind power production. Since 2010, 913 MW of lignite-fired capacity has been retired from seven plants (the Megalopoli I and II, Ptolemaida I, II, III and IV and LIPTOL plants)[512]. In recent years, over 3.7GW of planned coal-fired capacity in Greece has been cancelled, with any new lignite-fired power assets at risk becoming stranded[513]. Regardless, there is a rising trend in renewables in Greece and 2016 was the first year that renewables surpassed lignite in their share of electricity production. Whilst lignite's share collapsed to 29% (or less than 15 TWh), renewables, including large hydropower resources, reached 30% of electricity production. Natural gas was the third largest contributor with 24% of electricity production, with the remaining demand covered by imports – mainly from Bulgaria[514]. Moreover, some positive price signals have been introduced, targeted at the PPC's coal power production and mining, although these are undermined by the continued subsidies to coal. A lignite levy introduced in 2012 charges the PPC €2 per MWh for electricity

[508] (Μάντζαρης, 2018)
[509] (World Energy Council, 2016)
[510] (Neslen, 2016)
[511] (Global Plant Tracker, 2016)
[512] (Mantzaris, 2017)
[513] (Global Plant Tracker, 2016)
[514] (Independent Power Transmitter Operator (IPTO), 2016)

generation by lignite power plants. Meanwhile, the PPC is charged a tax earmarked for local communities where mining takes place, equivalent to 0.5% of PPC's turnover[515].

However, Greece's current government has proposed the development of two new lignite units, which are estimated to cost approximately €2.4 billion, even though it is unlikely that these will be economically viable without government support. These are the 660MW mega unit at the Ptolemaida V lignite plant, already under construction scheduled to operate in 2022 and the 450MW, Florina (Meliti II) unit, for which the PPC signed a Memorandum of Understanding with the Chinese construction company CMEC. The new lignite assets are estimated to emit approximately 7 million tonnes of CO2 a year once operational. [516] Despite its commitments, Greece continues to provide high subsidies to coal, while plans for phasing out this support are lacking. At the national level, the majority of financial support to lignite is provided through the capacity remuneration mechanism. This provides support to lignite power plants in exchange for the ability to produce electricity, equivalent to €40,423 per MW of electricity production in 2013 and totaling €149 million in support of lignite power plants that year[517]. Greek government support is also provided in the form of an excise tax refund for energy products that are used within the EU (including coal), which are estimated at a total of €1.3 million annually for coal 2006-2014 while an excise tax exemption is granted to consumers in the use of coal and coke[518].

Lignite-fired power in Greece is not only increasingly uneconomic, but also creates high social and environmental costs – with coal power emissions in the country estimated to be twice those in France and Portugal. In terms of its proportion of total power emissions, Greece is the fourth largest emitter from coal production in Europe. In 2015, coal-fired emissions accounted for 31% total CO2 emissions in Greece, equivalent to 29mt of CO2e[519].These emissions create a health cost estimated at €1.6 billion and have caused over 550 premature deaths in 2013[520]. According to WWF analysis (2016) clean energy alternatives would create more jobs than the new lignite units[521].

The two new lignite power units, Ptolemaida V and Meliti II, which are likely to be uneconomic without government support, are receiving new subsidies through the PPC. The PPC has provided a €400 million to begin construction of the Ptolemaida V unit and it is likely it will need to meet some of the remaining €1.4 billion in costs[522].This unit is also being underwritten by a €739 million loan from a consortium led by KfW-Ipex, the German export bank, under the guarantee of the German Export Credit Agency Euler Hermes[523]. A memorandum of understanding has meanwhile been received for the Meliti II unit, signed between the PPC and CMEC (a Chinese construction company) in September 2016[524].

In addition, the PPC and the Greek government have made efforts to receive free emission allowances, under the *EU ETS article 10c derogation*, to support the operation of the Ptolemaida V and Meliti II unit – equivalent to between €1.8 and €2.5 billion in the fourth

515 (OECD, 2016)
516 (Neslen, 2016)
517 (Capros, 2014)
518 (OECD, 2016)
519 (Sandbag, 2016)
520 (Schaible, et al., 2016)
521 (WWF Greece, 2016)
522 (Neslen, 2016)
523 (Public Power Corporation S.A Hellas (PPC/DEI), 2013)
524 (EU Energy Press, 2016)

phase of the ETS[525]. As Arthur Nelsen argued, public funds from Europe's carbon trading programme, which was set up so as to help poorer countries reduce emissions towards a sustainable energy future, would help Greece to revive its lignite-based model building two plants that will emit about 7m tonnes of CO2 a year reporting Emmanuel Panagiotakis', the president's of the Greek public power corporation (GPPC) assertion that plants such as these would not be viable without access to free emissions allowances and Greek lignite production would be discredited, causing electricity costs to skyrocket and jeapordising energy security. The European parliament's industry committee approved a rule change allowing east European members to join the EU's 2020 climate package. Between 2013 and 2019, it allocated 673m free emissions allowances to coal-dependent countries whose GDP per capita was 50% below the EU average authorising the requests from Cyprus, Estonia, Lithuania, Bulgaria, Czech Republic and Romania. The number would be reduced each year, reaching zero in 2020. The Member States would put in place strict monitoring and enforcement rules to ensure that the economic value of free allowances was at least mirrored, if not exceeded, by a corresponding amount of these countries'investments on upgrading their energy infrastructure, diversifying energy sources, and clean energy[526]. In practice though, the derogation10c risked of being abused to facilitate investments in the new coal plants. WWF calculated that under the commission's proposal for revising the ETS and 10c rules, Greece would receive 7m free allowances every year between 2021 and 2030. The commission's estimated 'shadow' allowance price of €25 per tonne of CO2 over this period, would set the total handout at approximately €175m a year, or €1.75bn for the decade. These investments would be not only environmentally but also financially wrong, as they would never pay off. Consequently, the eligibility of Greece would violate climate targets and is in no way compatible with the leadership role the EU aspires to play in global climate policy and carbon markets[527].

Since the ETS is the most mature and sophisticated carbon pricing system globally, February's vote would send signals worldwide on how seriously the EU intends to fight climate change.The main purpose of this persistent plea is the subsidisation of the operation of two new lignite plants for a whole decade. Instead of accepting the global shift towards renewable energy after the Paris Agreement, PPC is refusing to invest in Greece's huge renewable potential. It blindly insists on the lignite path with two new lignite plants and attempts to finance their operation with ETS money.Through the construction of the two plants, PPC is hoping to reverse lignite's downfall, which saw its share plummet to 29% in 2016 from over 54% in 2012, before the third ETS phase begun, obliging EU's electricity sector to pay for its CO2 emissions[528].

Hopefully, the European Parliament Environment Committee (ENVI) has rejected these efforts through its decision in 15 February 2017[529]. Greece's exception based on Article 10c derogation was not included in the document of the Council of the Environment Ministers, with which the Council will enter the forthcoming tripartite negotiations with the European Parliament and the European Commission. European Parliament amendments have only granted Greece access to the Modernisation Fund (28 February 2017). In the text of the European Council, the use of funds could only be earmarked for the co-financing of decarbonisation of the electricity supply in the Greek islands and not for lignite plant

[525] (Neslen, 2016)
[526] (EUROPEAN COMMISSION, 2012)
[527] (Neslen, 2016)
[528] (Mantzaris & WWF Greece, 2017)
[529] (European Parliament, 2017)

retrofits, as energy infrastructure investments couldn't exceed the 450g CO2e per kWh limit[530]. Despite ENVI's loud and clear message to abandon lignite, 7 Greek MEPs from the political groups most closely affiliated with the two parties in Greece's government (GUE and ECR) tabled two amendments to change the base year for an article 10c derogation, which resurrect the exact same amendment rejected by the ENVI committee in December[531].As Arthur Nelsen has already argued since 2016 "the government under pressure from an EU refusal to write down its debts, focused on coal as an energy safeguard"[532].

Due to the persistence of Greece, Poland and other Member States, the Council agreed that existing coal plants may continue to receive capacity payments until 2035, a major retreat compared to the Commission's proposal and a clear contradiction to the Paris Agreement on climate change. The imposed lignite sale has already had a negative impact on European policy. Faced with the next to impossible mission of rendering lignite units attractive for potential investors, Greece was one of the loudest voices against the European Commission's proposal to exclude coal plants from subsidies known as capacity payments at the December Energy Council.The lignite sale imposed by the EU will end up hurting PPC and at the same time prolonging the country's dependence on polluting and expensive lignite for the decades to come. Thus, the EU should remove this stranglehold placed on Greece's energy future and encourage the Greek government to commit to phasing out lignite by 2030 as, one after another, its EU counterparts are doing[533].

Greek government efforts to meet the commitments to end fossil fuel subsidies should focus on phasing out the existing support provided under a) the capacity remuneration mechanism, b) coal tax exemptions to energy product manufacturers and c) energy consumers[534]. New financial support to the two new lignite-fired units, Ptolemaida V and Meliti II, through the 51% government owned PPC needs to be withdrawn. These investments are not likely to be economically viable, considering the unfavorable European legislative environment for investments in new lignite power and the use of highly polluting lignite in Greece. Support to lignite power capacity is undermining the operation of an open market in Greece's electricity sector. The Government should seek to pursue broader energy supply and investment policies to improve opportunities for cleaner energy technologies to support future electricity sector capacity – particularly given the higher potential for job creation[535].

The phase-out of coal subsidies should be seen as part of a wider global energy transition. WWF Hellas and Sandbag suggest absolute transparency regarding the management of surpluses and revenues generated by the ETS with no exceptions to the mechanism or further free allocation of allowances[536]. The funds released from the cessation of the project could be channeled into both major upgrading projects of existing lignite units to comply with ever stricter European environmental legislation for as long as they are still operating, as well as for RES and energy efficiency and storage investments[537]. According to Leah Worrall, the Greek government should continue to pursue efforts to the privatization of the Greek energy sector in order to

[530] (Council of the European Union, 2017)
[531] (Mantzaris & WWF Greece, 2017)
[532] (Neslen, 2016)
[533] (Mantzaris, 2018)
[534] (Organisation for Economic Co-operation and Development (OECD), 2015)
[535] (WWF Greece, 2016)
[536] (Mantzaris & WWF Greece, 2017)
[537] (Μάντζαρης, 2018)

promote an open energy market in Greece, which may also help to overcome the PPC's reliance on traditional lignite-fired power production[538]. Finally, an increase in the emission reduction target of the EU to 30% will lead to an increase in the carbon price and consequently it will yield in Greece revenues of 6 billion euros, increased by 2.9 billion euros in relation to current scenarios[539].

3. *Business as Usual vs RES, Energy Efficiency scenario*

Alternative scenarios were developed and assessed for the future evolution of the Greek energy system during the time period until 2050. The Business as Usual and Lignite Expansion scenarios do not lead to cheaper electricity, since they also include the cost of fuels and purchasing of emission allowances. Wind energy competes with lignite electricity generation for allowance prices in the order of 25 €/t CO2.The scenarios of a lower capital intensity, do not lead to a lower electricity cost compared to the other scenarios considered, given that they also involve charges for fuels and the purchase of emission allowances. The bigger investments in the scenarios with a higher RES penetration are offset by the higher operational cost for the scenarios characterized by larger conventional electricity generation shares. As a result, based on the scenario for the evolution of the emission allowance prices prescribed by the European Commission, the implementation of investments on new lignite units, such as Ptolemais V will lead to a significant increase in electricity prices.

In every scenario Greece fails to achieve the RES penetration targets for 2020 as prescribed in Law 3851/2010 for electricity generation. Specifically, taking into account current conditions in the market and the existing legal framework, all scenarios assume that it is realistic to introduce only 1,600 MW of newly installed RES during the period 2016-2020, which will finally lead to a 32.7% RES share in the gross final energy consumption, significantly lower than the set target of 40%. In order to achieve this target and assuming a 3:2 ratio of wind/photovoltaic generation, it was assumed that another 1,100 MW of wind systems and 1,100 MW of photovoltaic systems would be required.

The scenarios, in which fossil fuels maintain a significant share in electricity generation and which do not integrate strong energy saving policies in the final consumption sectors, fail to reach the energy and environmental targets set by EU for 2030. The RES percentage in the gross final consumption amounts to 25-26% (26-28% in 2035). GHG emissions are decreased by 36-42% compared to 2005 for the overall energy system, and by 47-57% in electricity generation. During the period by 2050, the decrease in emissions compared to 2005 amounts to 36-43% for the overall energy system and to 52-68% for electricity generation. On the contrary, the scenarios that include a strong RES penetration and, per case, more intense energy saving interventions in the final consumption sectors, present clearly better performances in terms of achieving the energy and environmental targets under discussion. For 2030, GHG emissions are decreased by 44-47% compared to 2005 for the overall energy system (51-55% in 2035), and by 61-65% in electricity generation (75-81%). During the period until 2050, the decrease in emissions compared to 2005 amounts to 50-64% for the overall energy system and to 75-88% for electricity generation.

In the long-term, the adherence to lignite electricity generation aggravates all the parameters of the Greek electricity system. Following the expected increase in the emission

[538] (Worrall, 2017)
[539] (Öko-Institut, et al., 2012)

allowance prices at European level as a result of the EU ETS reform, and in combination with the stricter European environmental legislation which imposes lower permissible emission levels and, therefore, costly upgradings, lignite no longer contributes to the decrease of the electricity cost as in the past, while at the same time it undermines the achievement of a series of energy and environmental targets. At the conventional electricity generation level, low emission allowance prices, below 30 €/t CO2, favour the radical upgrading of existing lignite units instead of the construction of new ones, while for higher emission allowance prices and up to some extent, the construction of new lignite units is more appealing from a financial point of view only in combination with higher natural gas prices in the market.

On the other hand, phasing out of lignite, in combination with a rational plan for RES development and energy savings in the final consumption sectors seems to combine the significant emissions' decrease in the energy and particularly in the electricity system, with lower electricity prices and achieving the targets for RES. RES technologies, and especially wind and photovoltaic systems, are technologically mature and already competitive to conventional units in financial terms. Wind energy seems to be competitive to lignite electricity generation for emission allowance prices in the order of 25 €/t CO2, while if the pumped storage cost is included in the RES cost, lignite electricity generation exceeds the RES cost for emission allowance prices in the order of 50-55 €/t CO2. A critical dimension in energy planning is energy savings, especially given the high rates of energy poverty among Greek households. The current and future energy saving programs will have to aim for a decrease in energy consumption, and an improvement of the energy services provided to the consumers[540].

Greece could drastically reduce its reliance on oil-fired power stations if the necessary interconnection projects were implemented by 2030 and RES hybrid systems were built in non-interconnected, remote islands. Lignite's share in electricity generation could drop to 6% by 2035 and 0% by 2050. Phasing out of lignite also proves financially more beneficial, as it would lead to lower electricity costs by even 12%, compared to the lignite-expansion scenario. Natural gas would reserve significant role while RES' share in final consumption could more than triple during 2005-2035. Ambitious energy efficiency policies could reduce the required investments for phasing out lignite by 2-5 billion euros. The energy sector's GHG emissions could drop significantly by 2035, mainly as a result of lignite's shrinking share with the largest possible reduction counted to 64% by 2005[541].

The necessary cumulative investments range between 23 bil. € (lignite expansion) and 33 bil. € (RES).The integration in the electricity system of the intermittent RES at this scale creates additional needs in energy storage. It is therefore concluded that in order to achieve the environmental and energy targets discussed by the EU for 2030 and 2050, extremely high investments on RES technologies will have to be planned in the electricity generation system. The promotion of energy saving policies in the final consumption sectors seems to somewhat mitigate the necessity for new investments on RES[542].

However, it should be noted that extremely strong efforts will be required in order to achieve the energy saving targets with the implementation of relevant programs. Since the country has gone through a decade of unprecedented shrinkage in GDP and family income,

[540] (Moirasgentis, et al., 2017, pp. 83-85)
[541] (WWF, 2017)
[542] (Moirasgentis, et al., 2017, pp. 83-85)

it is estimated that the relative improvement of the economic conditions will bring about a strong rebound effect and, therefore, the implementation of programs for energy savings and energy cost reduction will contribute to the improvement in energy conditions within buildings, the increase in the transportation load serviced, etc., but the decrease in energy consumption will most probably be smaller than the expected one [543].

[543] (Moirasgentis, et al., 2017, pp. 83-85)

IX. Conclusions

In the wake of the twenty-first century climate change is gaining great interest between scientists and politicians. Although it is a complex phenomenon, subject to great uncertainty, as it is unlikely to be catastrophic in the near term, climate change has the potential for serious damages in the long run. More specifically, as it is estimated the total discounted economic damages with no abatement are on the order of $23 trillion. [544]These damages can be significantly reduced by well-designed policies whereas poorly designed ones are unlikely to reverse the present situation. Similarly, overly ambitious projects are likely to be full of exemptions, loopholes, and compromises and may cause more damage than benefit.

Such well-designed policies should also take into great consideration the scarcity of natural resources so as to allocate them in the most efficient way. As a solution to this problem Adam Smith proposed the idea of an invisible hand that would represent the tendency of free markets to regulate themselves by means of competition, supply and demand, and self-interest of rational actors[545]. However rationality, a game theory's also prerequisite, shouldn't be only about the maximization of payoffs of players but also about the minimization of costs, including the negative externalities like pollution. As it was indicated through the present research sometimes it's preferable for the players to abandon the winner's strategy(Nash equilibrim) and choose the loser's one cooperating with each other(Maxi-min strategy), in order to avoid a "crash" with unrecoverable damages such as the end of the mankind due to global warming.

The economics of climate change and the economics of exhaustible resources could not be more closely intertwined. As it was concluded through the present research, in contrast to Adam Smith's assumption[546] unfortunately markets alone are unable to find the optimal path for this double stock-adjustment problem, as market failures such as information asymmetry, not internalized in the prices externalities, strategic behaviour and market abuse by firms with significant market power give the wrong price signals distorting the private incentives and leading to an inefficient allocation of resources. In this context state intervention through regulation so as to correct the above market failures and not to distort the free market's function is inevitable.

Furthermore in the context of globalization, liberalisation of trade offered great possibilities of economic efficiency, i.e. increased productivity of products of high quality in the lowest price due to increased economies of scale. Subsequent fierce competition between firms incentivized even lower prices through investments in R&D, innovations and advances in clean technologies (RES) leading to environmental improvement. Countries with heterogeneous institutions have rarely been so integrated. However trade openness was also accused by some scientists of magnifying the environmental regulatory gap between countries commited with high environmental standards and ones with lax environmental regulations (*"Pollution Havens"*) and bad governance (*"Corruption Paradise"* [547]) giving just the opportunity to the first (rich developed countries or *"North"*) to export their pollution to the second (developing countries or *"South"*), so that the total environmental improvement is nil. To this context WTO and UNFCCC seem to be two regimes opposing to each other. Greater understanding of the climate risk could lead to a global coordination

[544] (Nordhaus, 2008)
[545] (Smith, 1776)
[546] (Smith, 1776)
[547] (Candau & Dienesch, 2016)

mechanim through the design of trade and climate policies mutually reinforcing instead of opposing.

More specifically, emissions trading, a market-based policy measure applying the Law of Supply and Demand, offers Europe the chance to achieve its emissions reduction commitments in an economically efficient way. As it is stated: *"The EU ETS has proved that putting a price on carbon and trading in it can work. Emissions from sectors covered by the system are falling, as intended. Their reduction was slightly over 8% compared to the beginning of phase 3. In 2020, they will be 21% lower than in 2005, exceeding EU targets while in 2030, under the revised system, 43% lower"*[548]. The expansion of renewable energy, which unlike fossil fuels can be sourced domestically, and the improvement of energy efficiency decrease GHG emissions while lowering EU's dependence on imports from non-EU countries, enhancing energy security of supply, strengthening its competitiveness, creating jobs, reducing health costs and contributing to the Europe 2020 strategy's objectives. If the EU can show that a low-carbon economy is feasible while increasing innovation and employment, it will serve as a role model to other regions upholding technological leadership. A successful clean energy transition, will create the conditions for sustainable growth and investments. Experts emphasize the EU's constructive role in international climate diplomacy. However, they criticize its weak decision-making processes and its slow progress in putting in place new and more ambitious policies and targets. EU ETS trying to protect sectors exposed at great risk of carbon leakage from the loss of their competitiveness (*"grandfathering"*) ended up being ineffective, its initial purpose cancelled. Projections show that further efforts will be necessary to put the EU on track to meeting its 2030 targets and its long-term decarbonisation objective of reducing emissions by 80–95% by 2050 compared with 1990 levels, as a fair contribution to the global climate change mitigation efforts.

To sum-up only coordination policies at global level regarding environmental standards, governance, trade and institutional integration can really reverse the current situation. Due to the failures of past global collective actions on these subjects, the future looks less bright with validations of distortive mechanisms than without. As it can be concluded through this research the most efficient approach for successful policies to combat global warming is the one that gradually introduces *internationally harmonized BCA based on BTA benchmarks (RES)*, ones that quickly become global and universal in scope and harmonized in effect. In that way governments could intervene correctively regulating trade in case - and only when – market and market-based policy mechanisms like EU ETS, as well, failed. Extracted revenues could be used to finance investments in developing countries' clean technology.

[548] (Europa)

X. References

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