INTERNATIONAL ENVIRONMENTAL AGREEMENTS: THE KYOTO PROTOCOL AND THE CASE OF GREECE

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INTERNATIONAL ENVIRONMENTAL AGREEMENTS: THE KYOTO PROTOCOL AND THE CASE OF GREECE

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INTRODUCTION

Nowadays one major problem that concerns the whole earth and needs immediate remediation is *pollution*. Environmental pollution is a classic example of an externality, in the way that is an external effect to individual firms, households or even provinces and countries.

When pollution and its effects are not concentrated in one country, but are associated with cases where activities in one country create negative externalities not only in the country itself, but also in other countries, then policies to regulate environmental externalities acquire *international dimensions.*

A large amount of pollutants are discharged in the atmosphere and water systems, as a result of human activity in each country. The emissions often affect other countries, as well as the global environment. A transboundary pollution problem exists when environmental pollution crosses national boundaries, for instance the pollution of rivers and lakes that border more than one country, while a global externality exists when the whole planet is affected by the environmental problem, like the ozone depletion, global warming, and the loss of biodiversity.

In economic terms, each polluting country benefits from using the environment as a receptacle for emissions but, at the same time, is also damaged by environmental deterioration. While the benefit is related to domestic emissions only, the damage is related to both domestic and foreign emissions which negatively affect the environment. Hence, a problem of international externalities arises which, in the present institutional setting, can be solved only by voluntary agreements among sovereign countries. Such agreements have been quite common in recent years[1].

Models used to evaluate policy options associated with transboundary pollutants are often appropriately structured as dynamic games. This is the case when the actions of each player (country) have an impact on those of all other players (countries). The design of an appropriate policy to address the impacts of a transboundary pollutant, such as global climate change, requires estimation of each player's benefits and costs of meeting a predetermined target.

The purpose of this thesis is to define coalition stability, likewise to present the recent theoretical developments of environmental agreements and stability. It considers several features: policy instruments, incentives for environmental protection, coalition formation, sustainable coalitions, international trade, ancillary benefits, International Agreements in

[1] More than 150 International Agreements have been signed to protect the environment in various regions.

practice. It focuses on the most crucial environmental agreement that has been signed from countries all over the world, the Kyoto Protocol.

The Kyoto Protocol on climate change imposes ambitious targets and timetables for emissions reductions by industrialized nations, and it expands significantly the opportunities for countries to achieve their commitments cost- effectively through emission trading and other “flexible mechanisms”.

The idea of using tradable permits to control pollution emerged from a theoretical debate over the economics of externalities. This thesis analyzes how emission permits will come into force, their costs and benefits, their impact on business, problems that may arise. The analysis concerns countries from the whole world and European Union. The case of Greece will be examined in detail.

1. ENVIRONMENTAL AGREEMENTS

1.1 International Agreements

International pollution problems have become increasingly important issues on the agenda of politicians, economists and natural scientists. A large amount of pollutants is discharged in the environment, as a result of human activity in each country. Some emissions are transported in the atmosphere and in the water and affect other countries as well as global environment. Prominent examples of such trans- frontier and global pollution are the acidification of lakes and soils through sulfur and hydrogen oxides, the depletion of the ozone layer through chlorofluorocarbons (CFCs) and the rise of atmospheric temperature through so called greenhouse gases.

According to the Intergovernmental Panel on Climate Change (IPCC 2001) the enhanced greenhouse effect, caused by anthropogenic emissions of greenhouse gases (GHGs) like carbon dioxide and methane, will negatively affect living conditions of current and future generations in almost all regions of the world. The enhanced greenhouse effect is a typical example of global common problem. In every country, a multitude of fossil fuel users (cars, lorries, households, industries and farmers) emit GHGs that dissipate into the atmosphere where they mix uniformly.

Climate change is a global environmental problem in the sense that only the total level of greenhouse gas emissions does matter in defining environmental quality, whereas which country actually emits is not relevant. As a consequence, an abatement action cannot be effective without widespread participation. However, the sovereignty principle implies that no institution in an international context can force countries to sign a treaty and therefore the harmonization of abatement policies has to hinge on a voluntary basis.

Climate change affects all world countries. Hence, the reduction of CO_2 concentration in the atmosphere benefits most, if not all, world countries. However, each country individually bears the cost of domestic policies designed to control greenhouse gases emissions. Moreover, most world countries have only a minor impact on total global emissions. These asymmetries, in benefits vs. costs, in actions vs. outcomes, are the source of many difficulties in achieving an international agreement on climate change.

A distinct characteristic of international pollution problems is that pollution does not remain within national boundaries. Consequently an optimal policy response would require that nations do not pursue a national but an *international environmental policy* where countries consider not only environmental damages at home but also those abroad caused by their emissions. This however requires *coordination* and *cooperation* among nations that is usually formalized in **International Environmental Agreements** (IEAs).

Since the global atmosphere is an open access depository of GHGs, individual polluters have no incentive to internalize their climate change externalities. As it is well known, a non- cooperative situation is not optimal from the global society's point of view. In order to reach a globally optimal solution, some kind of international coordination of climate policies is needed. However, economists are skeptical about the prospects of effective international policy coordination due to free- rider incentives and the lack of a supranational enforcement power.

The transportation of pollutants in the environmental media is a source as substantial interdependence among countries: each country receives a benefit from using the environment as a receptacle of emissions and is damaged by environmental degrading. While the benefit is related to domestic emissions only, the damage is related to domestic emissions and to foreign emissions which reach the country from other countries: hence a problem of international externalities which, in the present institutional setting, can be solved only by international agreements among sovereign countries.

1.2 Environmental Strategies

The general methodological approach in analyzing a global pollution problem follows the above steps[2]:

- determine the *non- cooperative* emissions, where countries choose to emit without taking into account the external cost that impose on other countries,
- determine a *cooperative* equilibrium, where countries choose their emissions by taking into account the cost of their emissions, so Pareto equilibrium is attained,
- establish the inefficiency of the non-cooperative equilibrium compared to the cooperative case,
- suggest a course of action that can achieve the efficient outcome.

In a dynamic formulation, it is useful to examine two alternative scenarios: the fully cooperative scenario, which presupposes a high degree of commitment to follow the agreed-

[2] See Xepapadeas (1997), pg 196.

upon emission policies, and the non- cooperative scenario, in which each country's emission policy is chosen to further its own interest, given the other country's emission policies. Technically, in the second scenario, we are looking for Nash equilibrium of a dynamic game. It should be emphasized, however, that Nash equilibrium need not be interpreted as an equilibrium that arises in the absence of negotiation[3].

The above approach is similar to the one used to deal with local pollution problems, with one institutional difference; when dealing with domestic pollution problem whatever policy is chosen by the regulator can be enforced given the legal framework associated with the problem. On the other hand, when a global environmental problem is examined, there is not a regulator with the power to enforce a given policy in a number of nations.

In the absence of some supranational authority with the legal power to enforce policies on different nations, the policy needs to be agreed upon. Negotiations among nations should lead to an international agreement, which specifies policies that should be adopted, by countries participating in the agreement.

Such agreements involve several difficulties related to the asymmetries of the countries concerned: the attitude towards the environment greatly differs among countries according to their preferences, their level of development and their environmental endowment. An additional difficulty is represented by the incentive to *free- ride*: each country would like to enjoy a cleaner global environment without paying for it, and this behavior can damage directly the cooperation among other countries.

Free- riding incentives which develop because of the common access character of the environmental problem and which can seriously impede the sustainability of the agreement. It might be in a country's best interest not to participate in the agreement to reduce emissions when the rest of the countries participate, since by doing so it can reduce its own cost of abating pollution and enjoy the benefits from the overall pollution reduction brought about by the cooperation of the rest of the countries. If countries have strong free- riding incentives, the agreement cannot be sustained. Hence there will always be a problem of potential instability of any agreement.

The free- rider problem is a situation that corresponds to a known game, *prisoner's dilemma*. In our case there is an international pollution problem with two players (two countries) and each must choose an action. The choice is binary. Each country must choose

[3] See Dockner E. J. and Ngo Van Long (1993), pg 14

either to *defect* from the agreement to reduce emissions neither to *cooperate* in reducing emissions.

In the absence of an IEA it is assumed that every nation takes other nation's environmental policy as given and chooses its optimal policy. The outcome is thus a non-cooperative Nash equilibrium of a simultaneous move game, inevitably leading to the so-called "tragedy" of the common property goods. No agreement for emission reduction can be sustained in this game. In such game, cooperation is profitable, but each country has an incentive to defect once the other countries cooperate. This leads all countries not to cooperate.

That prospect is set in a static framework and therefore does not take into account the fact that a country's time path of emissions may depend on the country's past behavior (either directly observed or indirectly inferred from observation of the evolution of the stock of pollution). To the extent that each country realizes that the other country's future emissions may depend directly or indirectly on its own current emissions, the perceived feedback effect may cause it to choose a different course of action[4].

It should be noticed that static game theoretical approaches to transboundary pollution problems may be unrealistic because most environmental problems are dynamic and even possess structural time dependence. Thus, if time is taken into account, it will be seen that the international pollution control is modeled as a simple two- stage dynamic game.

In the first stage players (countries or regions) decide on their membership on coalition, decide non- cooperatively whether or not to sign the agreement (join the coalition) given the adopted burden- sharing rule. In the second stage coalition members choose their economic and abatement strategies, set their policy/ decision variables by maximizing their welfare function given the decision taken in the first stage and the adopted burden- sharing rule.

1.3 International Coalition Formation

Coalition theory focuses on the possibilities of forming stable agreements between agents in order to pursue a common goal. In the game theoretical literature on international pollution problems, agents means countries or governments, a coalition is a group of cooperating countries that aims at reducing emissions beyond the non- cooperative status quo and hence *coalition theory* is a method for analyzing the incentive structure of countries to participate in

[4] See Dockner E. J. and Ngo Van Long (1993), pg 14

an IEA and to comply with the terms of the agreement. On the other hand, *game theory* refers to the mathematical method analyzing and predicting the outcome of the interaction of agents[5].

The game theoretical analysis of the formation and stability of International Environmental Agreements has become an important branch in the environmental economics literature over the last two decades. Roughly speaking, two approaches can be distinguished: *repeated games* and *coalition games*. Repeated games analyze whether compliance with treaty obligations can be enforced in the long run with credible threats or punishments, invoking equilibrium concepts as for instance sub game perfect equilibrium. Coalition games analyze membership in IEAs, applying concepts of cooperative and non- cooperative game theory.

The cooperative approach is based on the *characteristic function* that assigns a worth to coalitions. The worth is the aggregate payoff to a coalition that it can secure for itself irrespective of the behavior of countries outside the coalition. In contrast the non- cooperative approach is based on the *valuation function* that assigns an individual payoff to each country for each possible partition of countries, called coalition structure[6].

For a fixed coalition structure payoffs follow from some assumption how countries choose their emissions. The standard assumption is that coalition members act as a single player maximizing the aggregate payoff to their coalition but behave non- cooperatively towards outsiders.

Analyzing coalition formation is a complex business. First, the decision about participation or membership has to be modeled. The features of this decision are called *the rules of coalition formation*[7]. Important rules are for instance the sequence of coalition formation (simultaneous vs. sequential process), the number of coalitions that can form (single vs. multiple coalitions), the nature of membership (free vs. restricted accession to a coalition) and the degree of consensus needed to form a coalition.

Second, the decision about the design of an agreement within a coalition has to be modeled. Important ingredients are the implemented global abatement level within the coalition, the allocation of the abatement burdens on the coalition members, the level and the donors and recipients of possible transfer payments, the type, level and the allocation of the obligations of sanctions in case of non- compliance.

Third, what stability of a coalition means has to be defined, and stable coalition structures have to be determined.

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[5] See Finus M. (2004), pg 7.
[6] See Finus M. and Rundshagen B. (2003), pg 1.
[7] See Finus M. (2004), pg 7.

The first and the second step concern the actual process of coalition formation. Ideally, this process should be modeled as an endogenous process that follows from the behavior of countries. The third step relates to the prediction of the outcome of coalition formation and depends on the notion of an equilibrium concept.

A likely minimum requirement for a country to participate in an agreement is that the country is better off under the agreement than it is without any international agreement. As long as there is no international law to enforce countries to participate in an agreement, each country can choose to be a free rider outside the agreement instead of participating in the agreement.

Though the various models differ in many aspects, they all share one fundamental assumption: there is no third party like an international agency that can implement cooperation and hence the parties themselves must enforce treaties. Due to the lack of a central authority, stability of the social optimum solution is difficult to obtain. Thus in the absence of an institution with international jurisdiction to enforce agreements, any agreement must be voluntary as well as multilateral.

1.3.1. Coalition Stability

A coalition must be stable in two different ways. Equilibrium coalition structures are determined by applying the concept of *internal* and *external* stability. The bulk of environmental economics literature has been using non- cooperative game theory to explain the problems of forming coalitions by applying the concept of stability. It is assumed that countries forming an international environmental agreement, a no- trivial coalition[8], coordinate their policies by jointly maximizing the aggregate welfare to their coalition.

An International Environmental Agreement is said to be internally stable if none of its members wants to leave and is externally stable if none of the outsiders wants to joint it. Generally stability of an IEA depends on three conditions:

- *Profitability*: each participant in an IEA must receive more than in the non- cooperative solution.
- *Participation*: no participant has an incentive to leave an IEA to become non-signatory.
- *Compliance*: no participant has an incentive to violate the terms of the agreement.

8 A no- trivial coalition is a coalition of at least 2 members.

The first condition is basic prerequisite for successful cooperation and may be seen as a necessary though not sufficient condition for participation and compliance. The 2nd and 3rd condition capture the phenomenon that even if an IEA is profitable to all participants, countries face two types of free- rider incentives. The first type is the incentive to remain a non-signatory or in the more general context, to belong to a coalition that contributes less to abatement than other coalitions. The second type is the incentive to join an IEA but to violate its terms. In both cases, free- riders save abatement costs but benefit from abatement efforts of neighboring countries.

In most IEAs the number of parties falls short of the total number of countries involved in the externality problem and involved countries means not only all countries that emit and suffer from a pollutant but also all countries that emit a pollutant. This observation is particularly true for those IEAs with explicit and ambitious targets[9]. Furthermore, there is ample evidence that even if countries participate in an IEA, they do not always comply with their abatement obligations. This applies not only to IEAs regulating pollutants but applies to IEAs in general and has been confirmed by many empirical studies on compliance conducted by political scientists[10].

It turns out to be too complex for game theorists to construct a model that simultaneously captures all three stability conditions. Though all models capture profitability in some way, they focus either on participation or compliance.

1.3.2. Coalition Distortions

There are probably two major obstacles which explain the difficulty to achieve self-enforcing agreements with a large number of signatories. The first one is the large economic and environmental asymmetries across world regions. Less developed countries, for instance, are quite reluctant to adopt measures to control global pollution because this could slow their growth with high economic costs which are evaluated as larger than the environmental benefits resulting from emission reduction. In other words, signing an environmental agreement may not be profitable for all countries involved in the negotiation process.

The second problem is the intrinsic instability of environmental agreements. In words, some countries may prefer to free- ride to profit from the emission reduction achieved by the

[9] For instance, almost all countries emit and suffer from the global pollutants CFCs and greenhouse gases, which thus amount to roughly 200 countries. However, only 38 industrialized countries have originally accepted greenhouse gas emissions ceilings under the Kyoto Protocol in 1997 and the US, as a major polluter, withdrew from the Protocol in spring 2001.

[10] For instance, no less than over 300 infractions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) signed in 1973 in Washington have been countered per year.

signatory countries, because the environmental benefit is not excludable. This phenomenon is not related to the presence of asymmetries, even if asymmetries can strengthen it, and it occurs even if countries are identical.

Therefore even when all countries are conscious that gains from environmental cooperation are above the economic costs of abating pollution, i.e. that cooperation is profitable, most of them may not sign the environmental agreement because of the possibility to achieve the environmental benefit without paying the costs (i.e. cooperation is unstable).

At this point another extension should be attempted and asymmetric information should be introduced. Countries' preferences can hardly be observed. If we remove the assumption of complete information, each country that is induced to enter a coalition would be tempted to overstate the damage and claim for greater incentives. The solution to this problem is to embody an appropriate information or self- selection premium in the transfer to each country that enters the coalition[11].

1.3.3. Number of Signatories.

A main feature of international treaties is the clause that a treaty will only come into force if a minimum number of signatories or a minimum degree of effectiveness is achieved. For example, in the case of the Kyoto Protocol, the clause is twofold: the Protocol comes into force only if at least 55 countries sign it and the signatories represent at least 55% of total emissions. More generally, almost all international environmental treaties contain a minimum participation clause[12].

As far as it concerns the number of countries that form a stable coalition, the empirical evidence suggests that framework conventions that only constitute declarations of intentions enjoy almost full participation but that fewer countries sign IEAs with serious and ambitious abatement obligations. The empirical evidence is much in line with the prediction of theory[13]. The higher implemented abatement targets in an IEA are, the higher will be free- rider incentives and the lower will be participation and compliance.

Moreover theory also provides some rationales why a sub coalition (an IEA comprising less than all countries) may be superior to the grand coalition (an IEA comprising all countries), though the grand coalition has two advantages. First, the more countries sign an IEA, the smaller is the group of outsiders, which reduces leakage effects. Second, the more

[11] See Carraro C. (1993), pg 327.

[12] Only 2 out of 122 multilateral environmental agreements provided by the Center for International Earth Science Information Network do not contain any minimum participation rule.

[13] See Finus M. (2004), pg 15.

countries accede to an IEA, the more countries can shoulder abatement burdens and hence the easier is to design a cost- efficient allocation abatement scheme. In order to achieve a given global abatement target, individual countries in a sub coalition must contribute much more to cooperation compared to the grand coalition, which may drive up unit abatement costs substantially. This is particularly true if many countries with low unit costs of abatement do not accede to an IEA.

However, the grand coalition has also two important disadvantages. First, the more countries sign an IEA, the more difficult it is to agree on ambitious abatement targets. Since the signature of IEAs is based on voluntary participation, agreeing on the smallest common denominator within a large group of countries may lead to very lax environmental standards. Second, the more countries participate in an IEA, the more difficult it is to enforce compliance.

Overall, the net effect on the success of cooperation depends on whether the first two effects are stronger than the last two effects. From the theoretical literature it appears that a sub coalition is superior to the grand coalition for those parameter constellations which negatively affect the success of IEAs: a large number of countries suffering from pollution, a high degree of asymmetry between countries[14].

Thus, only a small number of countries can sustain the full cooperative outcome while, there is an inverse relationship between the maximum number of countries that can sustain full cooperation and the total gains to cooperation[15].

1.3.4. Transfers and Issue linkage

If we consider asymmetries and free-riding as two distortions in the objective of achieving a profitable and stable international agreement, then economic theory tells us that we need two instruments to make the correction. The two instruments that have been proposed in order to overcome these obstacles are *transfers* and *issue linkage*.

Transfers or side payments aim mainly at making the coalition profitable. The main idea is that "gainers" from the environmental coalition compensate "losers", through a transfer mechanism so that everybody is better off relative to the non- cooperative case. It is quite natural to propose transfers to compensate those countries which may lose by signing the environmental agreement. In other words, a re- distribution mechanism among signatories,

[14] See Barrett S. (1998), pg 6.

[15] Diamantoudi and Sartzetakis (2002) have found that a stable coalition consists of 2, 3 or 4 members if the total number of countries is greater than or equal to 5. Furthermore they showed that the welfare level of the signatories of a stable IEA is very close to its lowest value in comparison with the welfare level of signatories of other non- stable IEAs. Thus, the size of the stable coalition is not only very small, but it is very close to the worst, in terms of the members' welfare, coalition size.

from "gainers" to "losers", may provide the basic requirement for a self- enforcing agreement to exist, i.e. the profitability of the agreement for all signatories.

Although side payments of the direct transfer type make more efficient solutions possible, there is a good deal of resistance to their implementation.

Theoretically they signify application of a victim pays principle rather than a polluter pays principle which is contrary to international policy prescriptions. Moreover, the anticipation of such side payments may provide an incentive to initially minimize abatement policies even below non- cooperative levels thereby extracting larger side payments. This will be particularly relevant when initial cooperators have imperfect information about the preferences for environmental quality and abatement costs in the non- cooperative countries.

Two other reasons explaining why such side payments are rarely seen are the following: The first is their prejudicing effect of characterizing the victim country as a "weak negotiator". Secondly, such conspicuous financial side payments are perhaps unnecessary since the countries in question are typically engaged in several areas of negotiation; a condition which enables the countries to exchange concessions in fields of relative strength[16].

A system of financial transfers between "gainers" and "losers" is shown to be successful in guaranteeing the profitability of a world agreement, but not in solving the free- riding problem. This latter issue can be addressed by a second instrument: issue linkage. The basic idea of an issue linkage is to design a negotiation framework in which countries do not negotiate only in one issue, i.e. the environmental issue, but force themselves to negotiate on two joint issues, i.e. the environmental one and another interrelated economic issue (mirror game). The intuition is simple: if some countries gain from cooperating on a given economic issue whereas other countries gain from cooperating on another one, by linking the two issues it may be possible to obtain an agreement that is profitable to all countries.

Issue linkage was introduced into the economic literature on international environmental cooperation in order to solve the problem of asymmetries among countries. Issue linkage can also be used to mitigate the problem of free- riding.

The main advantage of linking issues is that international environmental agreements can become profitable and sustainable when[17]: (i) asymmetries among countries create gainers and losers in the move from the non- cooperative to the cooperative outcome, so repeated game arguments can not be applied to sustain cooperation, (ii) when transfers or side payments are not possible or convenient. The linking of two different issues makes it possible to sustain the

[16] See Folmer H. et al (1993), pg 315.
[17] See Xepapadeas (1997), pg 211.

cooperative outcomes as a sub game perfect renegotiation proof equilibrium in which the two players (countries) threaten to punish each other by defecting in both issues. Thus, in issue linkage cooperative solution is sustained as trigger strategy equilibrium, where each country threatens by defecting in both issues.

This outcome is feasible to the so- called asymmetric prisoner's dilemma in which no country is stronger than the other. Sustainability of cooperation through issue linkage can also be proved in the so- called suasion game, where one country is stronger, and the weaker country has an incentive to free- ride on the stronger country[18].

Transfers and issue linkage are probably the most popular proposed strategies, even though negotiation rules and treaty design can also be used to achieve equilibrium in which large size coalitions form at the equilibrium.

At the applied policy level, while transfers are rarely observed in IEAs, it is more common to have an International Agreement in which the agreement on the part of a country or group of countries to reduce emissions is linked to agreements among the same countries on other issues[19].

Trade restrictions are often used to influence some aspect of targeted nation's behavior other than its trade policies. Recent examples include trade sanctions against South Africa and Iraq[20]. In this way, potential free- riders are deterred with threats of trade sanctions or environmental cooperation to be linked to cooperation in Research and Development. If a country does not cooperate on the control of the environment, it loses the benefits of technological cooperation. Under an R&D agreement firms in signatory countries share the costs of R&D, implying that those firms reduce their marginal and average production costs compared to firms in non- signatory countries. The lower spillovers of R&D to outsiders are the higher is the degree of excludability and the larger is the competitive advantage of firms in signatory over firms in non- signatory countries.

Also in a trade agreement firms in signatory countries have a competitive advantage over outsiders through external trade barriers (tariffs or trade bans). Thus the strategy of this type of issue linkage is to raise the incentive for countries to contribute to pollution abatement via the threat that if they do not join the linked agreement they will also not enjoy the benefits from the agreement.

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[18] See Xepapadeas (1997), pg 213.

[19] For instance in the London amendment of the Montreal Protocol, the developing countries agreed to phase out the CFCs but their agreement was linked to technology transfers from the developed countries.

[20] As an example in the environmental arena, the United States threatened Japan with trade sanctions on imports of fish and other wild life imports (worth more than $353 million per year) if it continued to import shells of the endangered hawksbill turtle.

Linking environmental problems to non- environmental ones may become more likely, the greater the interdependency between the relevant countries become. This applies in particular to institutions like the European Community, which experience a strong increase in domains of cooperation. However, it can also be observed in other frameworks. For instance, in the development economics literature there is a growing tendency to relate dept forgiveness or interest rate subsidies to resource saving.

1.3.5. Effectiveness and Efficiency

Policy measures are called effective if they have a positive impact compared to some benchmark. This impact may be measured in ecological or welfare terms[21]. The few empirical studies measuring the effectiveness of IEAs suggest that implemented abatement levels are close to those which countries were to implement anyway if they would pursue their self-interest non- cooperatively national environmental policy. This has been confirmed for instance for the Montreal Protocol signed in 1987, the Helsinki Protocol signed in 1985 and the Kyoto Protocol signed in 1997.

Measures are called efficient if they achieve a target at minimal costs. As long as countries have different unit abatement costs, cost- efficiency requires that countries reduce emissions to a different extent. In reality, however, uniform solutions are part of many IEAs. The list of examples is long and includes the Helsinki Protocol, the "Protocol Concerning the Control of Emissions of Volatile Organic Compounds or Their Fluxes" and others.

1.3.6. Rationality

As it has already been mentioned cooperation can only be sustained by an international treaty if no country can gain by not being a party to it, and no party can gain by not implementing it. That is free- riding must be deterred and compliance must be enforced. An agreement must therefore specify a strategy- a plan detailing what parties should do- and this strategy, if obeyed must succeed in deterring free-riding and enforcing compliance. Moreover, it must be in the interests of the parties actually to behave as the strategy demands. That is, the threat to reciprocate, to harm a country that has deviated from the strategy, must be credible. Essentially, the assumptions of individual and collective rationality define what it is meant by a "credible" strategy.

[21] See Finus M. (2004), pg 3.

Rationality in game theory refers basically to optimization behavior as well as to common knowledge. *Individual rationality* implies that, if every other country plays the equilibrium strategy, each can do no better than to play this strategy; and that, if a country deviated from this strategy “by accident”, then this country would want to revert to the equilibrium strategy and so would each of others want to impose the punishment prescribed by the strategy, given that all other countries obeyed the strategy. That is, when push comes to shove, free- riding and non- compliance are punished; and is precisely because it is known that this behavior will be punished that no country deviates in equilibrium[22].

Collective rationality, implies that an equilibrium agreement cannot be vulnerable to renegotiation- that there cannot exist an alternative, feasible agreement that all countries prefer to the equilibrium agreement; that should a country deviate from the equilibrium “by accident”, not only would this deviant want to revert to the equilibrium strategy, and not only would every other country behave in the manner prescribed by this strategy, given that all others did so, but all of the countries called upon to punish the defection would actually want to carry out the punishment and would not be tempted to renegotiate the agreement- to choose an alternative, feasible punishment or overlook the defection and not punish the defector at all[23].

1.3.7. Leakage Effects

The term leakage effect describes the phenomenon that if coalition members increase their abatement efforts compared to the status quo, outsiders may reduce their abatement efforts. Though this counter reaction does usually not completely offset the efforts of signatories, it negatively affects the success of cooperation. Leakage effects are an implication of the fact that in the presence of transboundary pollution, abatement is a public good from which no country can be excluded. Thus, also non- signatories benefit from higher abatement efforts of signatories via lower environmental damages. Consequently, non- signatories pursuing only a national environmental policy feel less environmental pressure and adjust their abatement level downward. It is evident that the larger leakage effects are, the less successful will be cooperation.

[22] See Barrett S. (1998), pg 4.
[23] See Barrett S. (1998), pg 4.

1.4 The Paradox

It has been shown in the literature that the higher the number of countries affected by pollution, the higher are the free- rider incentives. The reason is that the more countries suffer from pollution, the smaller is the effect of an individual country on environmental quality. On the one hand, if a signatory free- rides, environmental quality will deteriorate only marginally. On the other hand, if a non- signatory contributed to cooperation via participation in and compliance with an IEA, environmental quality would only improve marginally. This finding has also been called *paradox* in the literature since it can be shown that cooperation is particularly important from a global point of view if many countries suffer from transboundary pollution. The reason is simple: the more countries suffer from pollution the higher is the degree of externality across countries if countries behave non- cooperatively and hence the higher are the global gains from cooperation.

The theoretical result suggests that the reduction of greenhouse gases would bring about large welfare gains due to the global character of this pollutant. However, it also explains why it has proved so difficult to establish cooperation under the Kyoto Protocol: only 38 countries singed the protocol and the US withdrew from the treaty[24].

1.5 International Trade

As the world economy has become more integrated, the relation between international trade and the environment has emerged as an important policy issue. Since the imposition of taxes or regulations to control pollution typically increases production costs, those in affected industries often raise concerns about how such policies will hinder their ability to compete with foreign firms. Similar issues arise when liberalization of the trade policy is concerned, since a trade barrier can provide shelter from foreign competition for a firm which is subject to environmental regulations. International trade affects directly the domestic production and consumption activities and is affected by different coalitions and cooperation.

Two lines of approach have been developed in the analysis of environmental policy and international trade. The first, the traditional one, is based on the assumption that producers and

[24] See Finus M. (2004), pg 11.

consumers behave competitively and only governments may or may not influence world prices, which is the usual large or small country assumption.

This approach leads to conclusions indicating that there is incompatibility between trade liberalization and environmental protection and that tough domestic environmental policies are likely to harm the international competitiveness of a country that adopts this policy.

The second line of approach is based on strategic international trade, and considers the case where producers as well as governments are allowed to act strategically. This approach leads in general to a variety of results. Depending on the assumptions made, the strategic trade approach could produce results supporting the idea of environmental dumping, or results supporting the idea that tough environmental policies might improve the international competitiveness of a country[25].

1.6 Ancillary Benefits

Climate policies initiate the reduction of atmospheric and biosphere GHG concentrations, and hence, the slowing of global warming, which provides primary benefits. But what has been widely omitted so far in the economic literature on climate change is that climate policies also induce ancillary benefits, benefits which result from climate policies but not from the slowing of climate change[26].

These ancillary benefits are not only considerable in size; they also exhibit characteristics which are different to those of primary benefits. Hence the consideration of ancillary benefits has not only quantitative impacts, it additionally induces qualitative effects.

Measures reducing CO_2 not only cause a decrease in CO_2 emissions but also an emission reduction of other pollutants. In general, positive health effects of air pollution reduction that accompany GHG control are considered to represent the most important category of ancillary benefits. Mortality is mentioned to be the crucial effect in the economic valuation of health effects. Other negative impacts of air pollution like accelerated surface corrosion, weathering of materials and impaired visibility are also mitigated by fuel combustion reductions.

Improved air quality also causes a reduction of the vegetation harming acidic deposition of photochemical oxidants. Furthermore, road traffic reduction as a means to reduce fuel

[25] See Xepapadeas (1997), pg 229-230.
[26] See Markandya A. and Rubbelke D. (2003), pg 1.

combustion generates not only ancillary benefits from reducing the emission of air pollutants; less traffic congestion and road surface damage.

There are also benefits of climate policies that are associated with employment effects or technological change. By levying carbon taxes, funds are collected which could be used to remove distortionary labor taxes, i.e. taxes which rise labor cost and induce a sub- optimal low employment of labor force. With it the price of the factor labor declines and employment is raised. In recent years a large strand of literature discussed double dividends of environmental tax schemes which recycle revenues by reducing labor cost. The dividends of such revenue recycling are on the one hand the carbon- tax induced improvement of environmental quality and on the other hand the increase of employment by reducing labor costs.

There are several differences between primary and ancillary benefits of climate policy, which have qualitative as well as quantitative impacts. The immediate occurring of ancillary benefits makes discounting unnecessary and gives these benefits a higher weight compared to primary benefits which are expected in distant future. The requirement of scientific knowledge to assess primary benefits exceeds the one of the estimate of ancillary benefits.

Furthermore, ancillary benefits could have a considerable impact on the GHG abatement levels as well as a privatizing impact on the “global public good” nature of climate policy. The privatizing effect is induced by the private character of ancillary benefits: ancillary benefits are national/ regional, while primary benefits are global. Consequently, climate policy should be treated as an impure public good from an individual country’s point of view. The privatizing impact helps to narrow the gap between an individual countries’s optimal and the Pareto-efficient abatement level[27].

1.7 General Characteristics of Environmental Agreements

Reading the relevant literature few key results emerge. These are developed in the following lines:

- The strategic interaction among countries in a common environment does not necessarily lead to the “tragedy of commons”, but there is a wide range of possible voluntary agreements to control emissions, (Carraro 1993)

[27] See Markandya A. and Rubbelke D. (2003), pg 9.

- Beyond non- cooperative emission control, there exist partial cooperative agreements among sub- groups of countries (coalitions) which are profitable and stable, (Carraro 1993)

- Gains from partial cooperation can be used to expand existing coalitions by inducing other countries to cooperate using self- financed welfare transfer, (Carraro 1993)

- Whenever full cooperation (social optimum) would generate large global welfare gains compared to no cooperation (Nash equilibrium), stable coalitions achieve only little, (Eyckmans 2003)

- Small coalitions may achieve more than large coalitions in terms of global welfare and emission reduction, (Eyckmans 2003)

- Even in cases where positive spillovers are and even without any commitment to cooperation, countries may form a coalition. This coalition is usually formed by a subgroup of the negotiating countries, (Carraro et al, 2003, pg 3-4)

- The sometimes small coalition maybe expanded by means of transfers or through issue linkage, but only under some restrictive conditions,

- The outcome of the game strictly depends on the membership rules that are adopted by the negotiating countries, (Carraro et al, 2003, pg3-4)

- When multiple coalitions can and do form, the equilibrium is characterized by several, often small, coalitions, (Carraro et al, 2003, pg3-4)

- The longer the planning horizon and the less countries discount time, the more successful will be cooperation. Most international pollutants are stock pollutants which persist for a long time in the environmental systems. Thus, abatement efforts taken today have immediate impact on abatement costs but have only a positive impact on climate in the far future. Thus, if governments are myopic and/or discount time much, they do not realize benefits from abatement and will therefore not join an IEA,

- A coalition where countries cooperate on too many issues may be formed by a few countries, which implies small spillovers among them, whereas coalitions in which cooperation is restricted to few issues may be joined by many countries, thus raising many positive externalities within the coalition, (Carraro and Marchiori, 2003, pg 3)

- The decision to sign the R&D agreement has two positive effects for the signatories: on the one hand, production costs decrease because co- operative R&D makes more efficient technologies available; on the other hand, market share increases because firms with lower costs have higher market share,

- Cooperation on research and development may create economies of scale effects. This can reduce abatement costs and may thus encourage participation in IEAs,

- Small IEAs may be superior to large ones since more ambitious abatement targets can be implemented and compliance can be better enforced.

For the globally or socially optimal solution some general characteristics hold:

- The higher aggregate benefits are compared to aggregate costs from global abatement; the higher is the globally optimal abatement level and vice versa,

- Those countries with lower costs per unit of abatement (marginal abatement costs) should reduce pollution more than those with higher cost per unit of abatement,

- If some countries face similar unit costs of abatement, then those countries that cause a higher environmental damage should abate more than countries which cause relatively lower environmental damage.

The first feature guarantees that the choice of the global abatement level is based on rational principles. It recognizes that abatement reduces environmental damages but is also associated with costs in the form of forgone production and consumption of goods.

In particular, it recognizes the following relations. On the one hand, costs increase more than proportionally with increasing levels of abatement. That is, at high levels of abatement, an additional unit of abatement involves higher unit costs than at lower levels since more sophisticated abatement devices have to be implemented. On the other hand, benefits increase less than proportionally with increasing abatement levels. That is, at high levels of abatement, an additional unit of abatement generates less additional benefits (marginal benefits) since environmental quality is already high.

The second feature guarantees cost- efficiency. That is, abatement levels should be allocated to the various countries in such a way that the globally optimal abatement level is achieved at least cost. This feature is particularly important if an ambitious abatement level is implemented in order to keep costs at moderate and acceptable levels.

The third feature guarantees ecological efficiency. It does not apply to global pollutants but only to regional pollutants where the distributional pattern of the deposition of emissions matters for global damages. For instance, Great Britain should reduce more sulfur emissions than other countries since most of its emissions are transported to Nordic countries with sensitive ecological systems where emissions cause much environmental damage.

1.8 International Agreements in Practice

Transboundary or global environmental problems should be addressed through multilateral, international agreements which can be sustained through direct transfers of resources, through technology transfers or by linking the externality with other issues of mutual interest. Forming and sustaining an environmental agreement that involves substantial and asymmetric economic costs is not an easy task. Despite that fact there is a sizeable collection of Multilateral Agreements (MEAs).

The Convention on International Trade in Endangered Species (CITES) which was negotiated in 1973, the Montreal Protocol on Substances that Deplete the Ozone Layer which resulted in the phasing out of most use of chlorofluorocarbons, the Kyoto Protocol on Global Climate Change, negotiated in 1997. Kyoto Protocol is the issue to be developed further in the next session of this thesis.

Apart from MEAs, there are agreements regarding Technology and Environment. A very interesting recent agreement has been contracted between Italy and United States on research and technology associated with climate change. The two countries convened a bilateral "Joint Climate Change Research Meeting" in Rome on January 22-23, 2002.

Ending, is rather encouraging to mention that nowadays most of the countries in the whole world are environmentally sensitized[28].

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[28] In the Appendix, at the end of this thesis, there is a table containing the main International Agreements that have been signed.

2. THE KYOTO PROTOCOL

2.1 Historical Retrospect

Climate change due to anthropogenic greenhouse gases (GHGs) has emerged as one of the most important issues facing the international community. Greenhouse gases – particularly fossil fuel based carbon dioxide emissions- are accumulating in the atmosphere as a result of human activities, and the ongoing increase in greenhouse gases concentrations is expected to raise the global average temperature and cause other changes to the climate. Global consensus exists that climate change represents a significant potential threat which requires a considerable reduction of greenhouse gas emissions.

Given the public good character of the global atmosphere and the inherent free-riding incentives, the reduction of greenhouse gas emissions cannot be achieved without international cooperation, to be codified in international policy agreements. A good starting point for tracing the development of international environmental policy was the Stockholm conference of 1972, which resulted in the formation of the UN Environmental Program (UNEP). Climate change was of sufficient concern for the first world climate conference to be held in Geneva in 1979. Another landmark was the publication of "Our Common future" by the Brundtland Commission in 1987, which called for the protection of the atmosphere and the reduction of greenhouse gas emissions.

The Climate Change Convention was adopted in 1992 and provides the institutional framework for such agreements. At the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil[29], agreement was reached on the Framework Convention Climate Change (FCCC). In 1992 virtually all the countries of the world signed and ratified the United Nations Framework Convention Climate Change (UNFCCC), which established as its ultimate objective the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within time- frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".[30]

The signatories agreed to "formulate, implement… and… update… programs containing measures to mitigate climate change by addressing anthropogenic emissions by sources and

[29] Known as the Rio "Earth Summit", where the Agenda 21 was adopted.
[30] See Aldy et al (2003), pg 6 and http:/www.ieagreen.org.uk/polit.htm.

removals by sinks"[31] and to prepare periodic emissions inventories, promote development and diffusion of technologies for emissions control, and cooperate in adoption.

As an interim step, the FCCC imposed a non- binding goal of reducing greenhouse gas emissions by industrialized countries (the so- called Annex I countries) to their 1990 levels by the year 2000. The FCCC allowed countries flexibility to develop and implement their own domestic policies to achieve their goals.

Signed initially by 161 nations, the FCCC entered into force in January, 1994 after being ratified by 50 countries, including the United States. Today FCCC has 187 parties, more than any other international environmental agreement.

In December 1997, the Third Conference of Parties and about 160 countries negotiated the **Kyoto Protocol**, in the Japanese city of Kyoto. The Kyoto Protocol became open for signature on March 16, 1998, for a 1- year period. Under its provisions, it becomes legally binding 90 days following acceptance of at least 55 Parties, including Annex I countries accounting for at least 55% of the total 1990 carbon dioxide emissions from Annex I nations. Signature by the United States would need to be followed by Senate advice and consent to ratification.

Subsequent negotiations filled in many of the details of the Protocol and the Treaty was substantially completed by November, 2001. In the primary Kyoto Protocol only the targets, methods and timetables for goal action were set, while specific rules and many of its operational details were missing and needed to be negotiated in the subsequent Conferences of the Parties (COP) and subsidiary bodies[32].

Several categories of observer organizations attended sessions of the COP and its subsidiary bodies. These include representatives of United Nations secretariat units and bodies, as well as its specialized agencies and related organizations. Observer organizations also include intergovernmental organizations (IGOs) such as the OECD and its International Energy Agency (IEA), along with non- governmental organizations (NGOs)[33].

In order to advance on the operation details of the Kyoto Protocol, the so- called "Buenos Aires Plan of Action" has been decided at COP 4 in Buenos Aires, November 1998. However,

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[31] See http://www.eia.doe.gov/oiaf/kyoto/scope.html

[32] This is one of the reasons why the Protocol has not yet entered into force: many countries signed the Protocol, but only very few ratified it: The ratification status of the Kyoto Protocol as of March 6th, 2002: 84 countries signed the Protocol (and accepted it in this way officially), but only 49 countries (mainly small island states) ratified it.

[33] Currently 603 NGOs and 51 IGOs are accredited as observers. The NGOs represent different interests, including environmental groups, business and industry associations, local governments, research and academic institutes, parliamentarians, labour organizations and religious bodies.

only at the resumed COP 6 in Bonn, July 2001, Parties succeeded in reaching a political agreement on key issues under the Buenos Aires Plan of Action. On the basis of the Bonn agreement, parties at COP 7 in Marrakech, November 2001, managed to finalize the operational details of the Kyoto Protocol after heavy concessions to certain key countries, as e.g. Russia.

At COP 7, Parties adopted a decision on the compliance regime for the Kyoto Protocol which is among the most comprehensive and rigorous in the international arena. It makes up the "teeth" of the Kyoto Protocol, facilitating, promoting and enforcing adherence to the Protocol's commitments.

The Protocol maintains the principle of differentiated responsibilities by the industrialized and developing worlds, it imposes ambitious targets and timetables for emissions reductions by industrialized nations, and it expands significantly the opportunities for countries to achieve their commitments cost- effectively through emission trading and other "flexible mechanisms".

2.2 Imperative necessity for climate regulation

The Kyoto Protocol addresses probably the most profound and difficult global environmental problem that we face. Undoubtedly climate change control is a global governance problem. The exact implications of climate change remain impossible to quantify, but it is known enough to recognize that any rational response, including an element of precaution in the face of planetary uncertainties, must include significant efforts to limit emissions.

Any strategy to control climate change will only be effective if adopted by as many countries as possible, or at least by a number of countries which account for a large share of total emissions. However, due to the absence of a supranational authority that can enforce environmental policies and regulations on a global scale, climate change control can only be achieved via voluntary initiatives and international agreements among sovereign countries.

2.2.1 Greenhouse effect

Once, all climate changes occurred naturally. However, during the Industrial Revolution, we began altering our climate and environment through changing agricultural and industrial practices[34]. Before the Industrial Revolution, human activity released very few gases into the atmosphere, but now through population growth, fossil fuel burning, and deforestation, people are affecting even more the mixture of gases in the atmosphere.

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases:

Carbon dioxide (CO_2) is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, coal) and wood products are burned.

Methane (CH_4) is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.

Nitrous oxide (N_2O) is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include *hydro fluorocarbons* (HFCs), *per fluorocarbons* (PFCs) and *sulfur hexafluoride* (SF_6), which are generated in a variety of industrial processes.

In economic terms, greenhouse gases and conventional air pollutants are co- products. Hence, the benefits of CO_2 reduction must be equated to the full set of benefits of reduced fossil fuel (at least coal and oil combustion), whether it is achieved by regulation, conservation or taxation[35].

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat- absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide.

The greenhouse effect is a naturally process by which some of the radiant heat from the sun is captured in the lower atmosphere of the earth, thus maintaining the temperature of the earth's surface. It is essential for life on earth and is one of earth's natural processes. The gases

[34] Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%.

[35] An IPCC's statement reports that more than 2/3 of the carbon dioxide emissions in the atmosphere the last ten years is due to the combustion of fossil fuels. The rest is due to deforestation and cement's production.

that help capture the heat, called "greenhouse gases", include water vapor, carbon dioxide, methane, nitrous oxide, and a variety of manufactured chemicals[36].

Over the past several decades, rising concentrations of greenhouse gases have been detected in the earth's atmosphere[37]. Although there is no universal agreement within the scientific community on the impacts of increasing concentrations of greenhouse gases, it has been theorized that they may lead to an increase in the average temperature of the earth's surface. Already global surface temperatures have increased about 0.6^{o}C (plus or minus 0.2^{o}C) since the late - 19th century and about 0.4^{o}F over the past 25 years[38].

The warming has not been globally uniform. It is difficult to note such an increase conclusively because of the differences in temperature around the earth and throughout the year, and because of the difficulty of distinguishing permanent temperature changes from the normal fluctuations of the earth's climate. However, according to the range of possible forcing scenarios, and taking into account uncertainty in climate model performance, the IPCC projects a global temperature increase of anywhere from 1.4 – 5.8^{o}C from 1990- 2100.

The effects of climate change will be superimposed on other changes, including a general increase in the intensity of land use, forest clearing (which means the liberation of even more amounts of CO_2), ground water withdrawal, soil erosion and air and water pollution. Acidity, of course, is a consequence due to fossil fuel combustion.

Simulation studies on arid and semiarid river basins in the USA suggest that relatively small changes in temperature and precipitation have multiplier effects on run- off. There is evidence that run- off will increase in winter in high latitudes and decrease in summer in mid and low latitudes. These changes in run- off patterns "could greatly alter the likelihood of flooding and the availability of water during peak- demand periods such as irrigation seasons"[39].

Furthermore, the ice dissolvent and the thermal expansion of the ocean water will be the major cause of the expected sea level rise in the short term[40], while salt water will also move upstream via rivers into lowland, freshwater pockets behind coastal dunes, and into ground water aquifers. Epidemics, floods, drought, endmost weather phenomenon, poverty will then follow.

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[36] See figure 1 in the Appendix.

[37] Nowadays the emissions of carbon dioxide reach 6.8 megatons per year. It is reported that until 2100 this amount will probably reach 35 or 40 megatons per year. (http://physics4u.gr/news/2001/scnews262.html)

[38] See figure 2 in the Appendix.

[39] See Ayres R. U. and Walter J., (1991), pg 240.

[40] Global mean sea level has been rising at an average rate of 1 to 2 mm/year over the past 100 years, which is significantly larger than the rate averaged over the last several thousand years.

The most recent report of the Intergovernmental Panel on Climate Change (IPCC) concluded that: “Our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability, and because there are uncertainties in key factors. These include the magnitudes and patterns of long term variability and the time- evolving pattern of forcing by, and response to, changes in concentrations of greenhouse gases and aerosols, and land surface changes. Nevertheless, the balance of evidence suggests that there is a discernable human influence on global climate”[41].

Indicative was the following phrase that Jacques Chirac said on 2 September 2002 at the world Summit on Sustainable Development in Johannesburg: “Our house is burning and we look elsewhere. Nature, mutilated and over- exploited, can no longer reconstitute itself and we refuse to admit it. Humanity is suffering. It is suffering from poor development, in the north as in the South, and we are indifferent. The earth and humanity are in peril and we are all responsible. It is time now to open our eyes”[42].

2.3 Sectoral allocation

According to the Protocol, there are three potential types of sectoral allocation from the European perspective. The Convention divides into three main groups according to differing commitments:

- Annex I Parties include the industrialized countries that were members of the OECD (Organization for Economic Co- operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States and several Central and Eastern European States.
- Annex II Parties consist of the OECD members of Annex I, but not the EIT Parties. They are required to provide financial resources to enable developing countries to undertake emissions reduction activities under the Convention and to help them adapt to adverse effects of climate change. In addition they have to “take all practicable steps” to promote the development and transfer of environmentally friendly technologies to EIT Parties and developing countries. Funding provided by Annex II Parties is channeled mostly through the Convention’s financial mechanism.

[41] See http://www.eia.doe.gov/oiaf/kyoto/scope.html
[42] See http://www.nmsi.ac.uk/creativeplanet/pdfs/creativeplanet.pdf

▪ Non- Annex I Parties are mostly developing countries. Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low- lying coastal areas and those prone to desertification and drought[43].

Others (such as countries that rely heavily on income from fossil fuel production and commerce) feel more vulnerable to the potential economic impacts of climate change response measures. The Convention emphasizes activities that promise to answer the special needs and concerns of these vulnerable countries, such as investment, insurance and technology transfer.

2.4 Kyoto Targets

Kyoto targets apply to six classes of greenhouse gases:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- hydro fluorocarbons (HFCs)
- per fluorocarbons (PFCs)
- sulfur hexafluoride (SF_6)

The Kyoto Protocol provides specific greenhouse gas emissions commitments for 38 industrialized (Annex II) countries for the first "commitment period" 2008-2012 (called Kyoto budget period). Essentially, each country can average its emissions over that 5- year period to establish compliance, smoothing out short term fluctuations that might result from economic cycles or extreme weather patterns.

Each country must have made demonstrable progress by 2005. No targets are established for the period after 2012, although lower targets may be set by future Conferences of the Parties. At the Committee's request, the Energy Information Administration (EIA) held the target for energy- related carbon emissions in the commitment period constant to 2020, the end of the forecast period.

These emission targets are expressed relative to countries' emissions in the year 1990. Transition economy countries were allowed to use a base year other than 1990 if their economic transition from central planning began prior to that date. Countries may also choose

[43] List of all Convention Member States from all groups is developed in table 2 and 3 in the Appendix.

to employ 1995 as the base year for measuring changes in emissions of the synthetic greenhouse gases (hydro fluorocarbons, per fluorocarbons and sulfur hexafluoride). The aggregate target is established using the carbon dioxide equivalent of each of the greenhouse gases.

The relative commitments range from 8% below 1990 levels (for the European Union) to 10% above 1990 levels in the case of Iceland. The EU agreed to cut down the overall GHG emissions relative to the 1990 levels by 8% in the period from 2008 to 2012. In 1998, the EU differentiated this target between their different member states in the so- called EU *Burden-Sharing Agreement.*

The idea was that the cohesion member states such as Spain, Portugal, Ireland and Greece are given lighter burdens, compared to richer countries. They are thus allowed to increase their relative small emissions while other EU member states stabilize or reduce emissions. The eastern European accession countries that joined the EU in May 2004 are not included in the Burden-Sharing Agreement but have their own individual Kyoto targets.

Considering the growth of some economies subsequent to 1990 and the essential collapse of others, the range of implicit targets is much greater, with the United States facing a target of about 30% below business- as- usual (BAU) levels in 2012, and Russia and other economies in transition facing targets that would allow substantial increases in emissions above anticipated BAU levels in 2012.

Likewise, Australia and Norway also are allowed increases of 8 and 1 percent, respectively, while New Zealand, the Russian Federation and the Ukraine are held to their 1990 levels. Other Eastern European Countries undergoing transition to market economies have reduction targets of between 5 and 8 percent. The reduction targets for Canada and Japan are 6% and for the United States, 7%.

Likewise, Germany's apparently ambitious Kyoto target of an 8% reduction translates into a targeted increase in emissions, due to the post- 1990 reunification of the two German nations, and the United Kingdom's target of an 8% reduction likewise translates into a targeted emissions increase, due to the privatization of British coal mining and the opening up of North Sea natural gas sources.

Non- Annex I countries have no targets under the Protocol, although it reaffirms the commitments of the Framework Convention by all Parties to formulate and implement climate change mitigation and adaptation programs and to promote the development and diffusion of environmentally sound technologies and processes. Developing countries can voluntarily enter into the Protocol by full amendment of the Protocol.

Specifically, the targets of all EU and accession countries are shown in the following tables:

Emission Targets for the Commitment Period 2008-2012	
European Union (of 15), Bulgaria, Estonia, Leetonia, Lithuania, Romania, Slovakia, Slovenia, Czech.	**-8%**
United States	**-7%**
Canada, Japan, Hungary, Poland.	**-6%**
Croatia	**-5%**
New Zealand, Ukraine, Russia.	**0%**
Norway	**+1%**
Australia	**+8%**
Iceland	**+10%**

EU Member States Differentiated Targets			
Luxembourg	**-28%**	France, Finland	**0%**
German, Denmark	**-21%**	Sweden	**+4%**
Austria	**-13%**	Ireland	**+13%**
G. Britain	**-2.5%**	Spain	**+15%**
Estonia, Leetonia, Lithuania, Slovakia, Slovenia, Czech.	**-8%**	**Greece**	**+25%**
Belgium	**-7.5%**	Portugal	**+27%**
Italy	**-6.5%**		
Hungary, Poland, Holland	**-6%**		

2.5 Member States commitments

According to the Kyoto Protocol Convention, each party included in Annex I, in achieving its quantified emission limitation and reduction commitments in order to promote sustainable[44] development shall[45]:

i) implement further elaborate policies and measures in accordance with its national circumstances, such as:

- enhancement of energy efficiency in relevant sectors of the national economy,
- protection of sinks[46] and reservoirs of greenhouse gases,

[44] Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
[45] See http://unfccc.int/resource/docs/convkp/kpeng.html

- promotion of sustainable forest management practices, afforestation and reforestation,
- promotion of sustainable forms of agriculture in light of climate change considerations,
- research on and promotion, development and increase use of new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies,
- progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the convention and application of market instruments,
- limitation and reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy.

ii) cooperate with other parties to enhance the individual and combined effectiveness of their policies and measures adopted under the Convention. These parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness.

iii) Strive to implement policies and measures in a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade and social, environmental and economic impacts on other parties, especially developing country parties.

iv) Parties included in Annex I that have reached an agreement to fulfill their commitments jointly, shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments.

v) If parties acting jointly do so in the framework of, and together with, a regional economic integration organization any alteration in the composition of the organization after adoption of the Protocol shall not affect the existing commitments.

vi) Parties shall individually or jointly ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of greenhouse gases do not exceed their assigned amounts.

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[46] Sink is a reservoir that uptakes a chemical element or compound from another part of its cycle. For example, soil and trees tend to act as natural sinks for carbon – each year hundreds of billions of tons of carbon in the form of CO_2 are absorbed by oceans, soils and trees.

2.6 The Kyoto Mechanisms

Sources of emissions include fuel combustion, fugitive emissions from fuels, industrial processes, solvents, agriculture and waste management and disposal. Several provisions of the Protocol allow for some flexibility in meeting the emissions targets. Net changes in emissions by direct anthropogenic land- use changes and forestry activities will also be used in meeting the commitment; however, these are limited to afforestation, reforestation and deforestation since 1990. There are developed three main mechanisms that can help countries achieve their commitments at lower costs:

- Clean Development Mechanism (CDM),
- Joint Implementation (JI) and
- Emission Trading System (ETS).

The *Clean Development Mechanism* defined in Article 12, provides for Annex I Parties to implement project activities that reduce emissions in non- Annex I Parties, in return for Certified Emission Reductions (CERs). The CERs generated by such project activities can be used by Annex I Parties to help meet their emissions targets under the Kyoto Protocol. Article 12 also stresses that such projects are to assist the developing country host Parties in achieving sustainable development and in contributing to the ultimate objective of the convention. The developed country is expected to cover the "incremental costs" of the project.

The current modalities and procedures for the CDM focus on activities that reduce emissions. A CDM project might involve, for instance, a rural electrification project using solar panels or the installation of more energy efficient boilers. Annex I Parties are to refrain from using CERs generated through nuclear facilities to meet their emission targets.

Clean Development Mechanism project activities must have the approval of all parties involved and this may be gained from designated national authorities[47] (to be set up by each Annex I and non- Annex I Party). CDM project activities must reduce emissions below those emissions that would have occurred in the absence of the CDM project activity.

The CDM is supervised by the CDM Executive Board, which itself operates under the authority of the COP. While the 10 members and ten alternatives of the Board are drawn from all constituencies of Parties, they act in their personal capacities[48].

Joint Implementation under Article 6 of the Kyoto Protocol provides for Annex I Parties to implement projects that reduce emissions, or remove carbon from the atmosphere, in other

[47] Parties participating in the CDM shall designate a national authority for the CDM.
[48] http://unfccc.int/kyoto_mechanisms/cdm/items/2718.php

Annex I Parties, in return for Emission Reduction Units (ERUs). The ERUs generated by JI projects can be used by Annex I Parties towards meeting their emissions targets under the Protocol. The term “joint implementation” stems from the Convention, which refers to the joint implementation of policies, but its usage has become commonplace for projects under Article 6 of the Kyoto Protocol.

A JI project might involve, for example, replacing a coal- fired plant with a more efficient combined heat and power plant. Most JI projects are expected to take place in the Annex I Parties with economies in transition in Eastern Europe. Annex I Parties are to refrain from using ERUs generated from nuclear facilities to meet their targets.

JI projects must have the approval of all Parties involved, and must lead to emission reductions or removals that are additional to any that would have occurred without the project. Projects involving land use, land- use change and forestry (LULUCF) activities must conform to the Protocol’s wider rules under Articles 3.3 and 3.4. Projects starting from the year 2000 that meet JI requirements may be listed as JI projects. However, ERUs may only be issued in relation to periods from 2008 onwards.

There are two possible procedures for carrying out a JI project. The first procedure may be applied when the Annex I Party hosting the project fully meets all the eligibility requirements to participate in the mechanisms. In this situation, the host Party may apply its own national rules and procedures to the selection of JI projects and the estimation of emission reductions from them. The host Party may also issue ERUs and transfer them to project participants.

The second procedure must be applied if the host Party does not meet all eligibility requirements. In such cases, the project and the quantity of ERUs it generates must be verified under rules and procedures supervised by the Supervisory Committee. In this case JI projects are allowed to begin operation before the host Party meets the eligibility requirements. However, before it may issue and transfer ERUs, the host Party must meet at least those requirements relating to the calculation of its assigned amount and the establishment of its national registry[49].

Even before the Kyoto Protocol, many analyses of the impacts of greenhouse gas emissions reductions have favored *Emissions Trading Programs*, including joint implementation programs, as a means of achieving emissions reductions. Permits issued to greenhouse gas generators allow them to emit up to a specified level of the gases. The Protocol

[49] See http://unfccc.int/kyoto_mechanisms/ji/items/1674.php

implicitly allows for trading across different types of gases and some limited trading across time.

Since emissions commitments represent the weighted sum of a country's net emissions of greenhouse gases[50], the Protocol implicitly allows inter- gas trading. By focusing on net emissions, the Protocol allows for (potentially cost- effective) substitution of carbon sequestration for greenhouse gas abatement. Emissions quotas refer to five- year averages, and countries are allowed to bank and borrow emissions allowances within this five- year window. Countries may also bank (but not borrow) emissions allowances for use in future, as- yet- undefined commitment periods.

Generators may reduce emissions by using lower- sulfur coals, installing scrubbers, or increasing the utilization of cleaner- generating plants. Generators that reduce emissions below their allowed levels can sell excess emissions permits, which can be purchased by other generators for whom it is more cost- effective to purchase permits at the prevailing market price than to reduce emissions.

Compared with traditional control programs that mandate specific compliance options or require uniform reductions, the trading program is credited with reducing the overall cost of compliance by allowing reductions to be made in the most cost- effective manner.

Emission trading among the Annex I Parties is permitted. The Kyoto Protocol provides for international emissions trading but defers the determination of specific guidelines and rules for establishing an open trading market and managing the international flow of funds for the purchase of permits. However, the Conference of the Parties is required to establish principles, rules, and guidelines for trading at a future date.

2.7 Compliance Mechanism

The compliance regime consists of a Compliance Committee made up of two branches: a *Facilitative Branch* and an *Enforcement Branch*. As their names suggest, the Facilitative Branch aims to provide advice and assistance to Parties in order to promote compliance, whereas the Enforcement Branch has the power to determine consequences for parties not meeting their commitments. Both Branches are composed of ten members, including one representative from each of the five official UN regions, (Africa, Asia, Latin America and the

[50] Greenhouse gas emissions are aggregated based on their 100- year global warming potentials, and are reported in terms of "carbon dioxide equivalent".

Caribbean, Central and Eastern Europe, and Western Europe and Others), one from the small island developing states, and two each from Annex I and non- Annex I Parties.

Decisions of the Facilitative Branch may be taken by a three- quarters majority, but decisions of the Enforcement Branch require, in addition, a double majority of both Annex I and non- Annex I Parties. The Committee also meets in a Plenary composed of members of both Branches.

In the case of compliance with emission targets, Annex I Parties are granted 100 days after the expert review of their final annual emissions inventory has finished to make up any shortfall in compliance. If at the end of this period, a Party's emissions are still greater than its assigned amount, it must make up the difference in the second commitment period, plus a penalty of 30%. It will also be barred from "selling" under emissions trading and within three months, it must develop a compliance action plan detailing the action it will take to make sure that its target is met in the next commitment period.

Any party not complying with reporting requirements must develop a similar plan and Parties that are found not to meet the criteria for participating in the mechanisms will have their eligibility withdrawn. In all cases, the Enforcement Branch will make a public declaration that the party is in non- compliance and will also make public the consequences to be applied.

2.8 Monitoring of Emissions

Articles 5, 7 and 8 specify the monitoring procedures. Each Party has to establish a national emission inventory system prior to the first commitment period. This includes an inventory of carbon sinks. The methodologies to estimate emissions as well as the conversion factor into global warming potentials are those agreed by the Conference of the Parties. The report has to be submitted annually and will be reviewed by a panel for compliance. The panel experts are nominated by the Parties to the Protocol.

The clear and uniform guidelines how to prepare inventories have to be judged positively. It does not leave room for different interpretations and eases to identify violations of the treaty. However, this statement has to be qualified considering the composition of the expert panel. Independence of the panel would have been served better if not any signatory were automatically granted a seat in this panel. The frequency of the reports ensures that violations are swiftly detected.

A major shortcoming is the fact that the inventory is not conducted by an independent scientific auditing panel reporting directly to the secretariat. In particular from countries which are undergoing a transition to a market economy reliable report can hardly be expected. This problem may be a major obstacle for establishing an efficient emission trading scheme for which reliable certified emission reductions are a basic prerequisite[51].

2.9 Estimating emissions

Methodologies for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases shall be those accepted by the Intergovernmental Panel on Climate Change and agreed upon by the conference of the parties (at its third session).

The Commission of EU suggests three models of allocating targets in its Non- Paper (European Commission 2003)[52]:

- The historical emissions approach (HIS)
- The forecasting approach (FUT)
- The least cost approach (LC)

In the *Historical Approach* the total number of allowances allocated to the ETS installations is determined by multiplying the share of emissions of ETS installations in a particular base year with the total allowable emissions in the economy. This approach together with the choice of a recent base year penalizes sectors or industries which have engaged in early action prior to the base year.

In the *Forecasting Approach* allowances are allocated according to the business- as- usual[53] shares expected at some future point in time, for example the end of the first commitment period to the Kyoto Protocol in 2012. This system would in some way reflect the expected needs of faster and slower growing sectors in the economy.

Finally, *Least Cost Approach* tries to take into account the fact that CO_2 abatement activities carry substantially different costs in different sectors. From an efficient point of view this would not matter if all emission sources were to participate in the trading scheme. But since abatement costs will equalize only within ETS, there is a danger that the Historical and

[51] See Finus (2000), pg 50.
[52] See Klepper G. and Peterson S. (2004), pg 10.
[53] Business- as- usual (BAU) includes the impact of policies, such as the German eco- tax or the national emissions trading schemes. From 2002 on, BAU keeps these policies in place but does not include any new climate policies.

the Forecasting Approach may lead to strong differences in marginal abatement costs between the sectors within ETS and those outside ETS. The Least Cost Approach tries to take into account of this inefficiency by dividing the cap between ETS and non- ETS sectors in such a way that the different abatement cost levels are recognized. Hence, the Least Cost Approach allocates relatively few allowances to sectors with low abatement costs.

2.10 The Case of USA

United States, despite the fact that they emit the 1/3 of greenhouse gases globally, withdrew from the agreement on March 2001, because Bush Administration regards that will harm American economy. In other words; the potentially most important buyer in a future market for emission permits is out of the market. With the largest permit demander dropping out, the demand for GHG emission permits has fallen, which implies a lower than expected carbon price.

US faces very high free- riding incentives, due to very high abatement costs, notwithstanding the possibility to make unrestricted use of emissions trading, which is meant to lower the costs of climate- change control. These high free- riding incentives have actually led to the US decision to withdraw from the Kyoto Protocol in its current form, blaming it for incurring significant costs on the US economy and for failing to involve the developing countries[54].

US stated that they prefer to adjust in a warmer world in the future and denunciate the Kyoto Protocol that does not take into account the greenhouse gases emitting from developing countries. Emission levels from those countries, US declare, will reach American levels quite soon.

The main reason why the United States wanted to establish flexibility in all dimensions can be found in the country's confluence of political interest and economic ideology. Politically, the US administration had to claim for the possibility to meet any commitments through action on other gases, sinks and international mechanisms because it faced a substantial uncertainty about what measures on CO_2 emissions could be ratified or implemented domestically. The United States succeeded with its claims concerning the flexibility for Annex I commitments. Besides the source and sink flexibility (the inclusion of

[54] See Buchner B. K. and Carraro C.(2003), pg 5-6

five other GHGs and of carbon “sinks”) the three market- based mechanisms for international emission transfers enable international flexibility in form of resource transfers and foreign investment. Due to this flexibility national emissions can diverge widely from the initial national commitments[55].

As a consequence of the US withdrawal from the Kyoto Protocol, the demand, and thus the permit price in the emissions market, fall and induce lower incentives to invest in energy saving and R&D in all countries. The US R&D sector therefore suffers from the decision not to participate in the Kyoto Protocol and these lower investments spill over onto the world economy. In addition, the lower total emission abatement induced by the US defection (i.e. the higher environmental damage) reduces output below its optimal level. This reduction is further enhanced by the presence of endogenous and induced technical change. A lower R&D effort, in combination with the increased emissions, implies both more damages from climate change and a lower growth rate of output in all countries.

Concluding, one can assume that different emissions trading regimes provide different participation incentives and that participation and optimal policy has to be jointly determined. These differences in participation incentives make it difficult to predict the future evolution of climate negotiations.

2.11 Competitiveness

Canada has ratified the Kyoto Protocol while the United States, its main trading partner (more than 80% of the international trade of Canada takes place with the US), have not. A major concern of Canadian industrial producers is the negative impact on competitiveness of programs designed to reduce greenhouse gas emissions. To alleviate this concern, the government of Canada is proposing an approach that puts a ceiling on the price of emission permits paid by industrial users and that allocate emission permits on the base of output.

Within the group of abating countries the heterogeneity argument pops up. First, the European Union has been assigned strongly binding targets, as opposed to others (for example Eastern Europe and the former Soviet Union). This argument also extents to the countries within the EU. Some countries were given less binding targets than other countries (the issue of burden- sharing).

[55] See Buchner B. K. and Schleicher S. P. (2002), pg 4.

Secondly, and equally important is the ability of countries to reduce emissions (costs versus abatement). This depends on the current energy and carbon intensity, and the existing energy prices, both at the macro- level and even more importantly at the sectoral level. But it also depends on the future developments of these indices. These factors are country and sector-specific and all determine the country's ability to cope with emission reductions.

Thirdly, some energy- intensive sectors are larger than others, and this coincides with large market shares by these companies in international markets. When strong and large companies are faced with higher energy prices and thus higher production costs, they can partly pass on these distortions to both domestic and foreign consumers.

Finally, some countries are energy- exporters, and some importers. The countries that export energy are generally the ones that will also be faced with lower production of energy sectors, simply because of the imposed fall of energy demand.

2.12 A Critical Approach

In the context of climate change, the Kyoto Protocol was welcomed as an important achievement in international diplomacy because for the first time, it succeeded in establishing binding emissions reduction targets for industrialized countries while the developing countries, including the large economies of India and China, were exempted from binding reduction targets in the first commitment period. And although it is fair to acknowledge that the industrialized countries are the main historic and present causers of anthropogenic climate change, the solution of the problem will need the implication of the developing countries. This is especially true if we assume that the developing countries will be able to develop as fast as they need[56].

As of January, 2003, the Kyoto Protocol has been ratified by 104 Parties (signed by 188) to the FCCC. That means that 28 Annex I countries had ratified the Kyoto Protocol, accounting for 43.95% of 1990 Annex I emissions. These include the member states of the European Union, Canada, Japan, the Czech Republic, Estonia, Latvia, Norway, Romania and Slovakia. Entry into force will thus require participation by other Annex countries especially Russia.

[56] In fact, the incorporation of the developing countries is the main issue on the negotiation agenda and the absence of binding targets for the developing countries was one of the main arguments used by President Bush to reject the Kyoto Protocol.

To secure the participation of Russia (and other Annex I countries, including Japan), negotiating Parties made the concessions in Bonn and Marrakech. Eventually the State Duma (the Russian parliament) ratified the Kyoto Protocol and the U. N. Framework Convention on Climate Change at its meeting on Friday, October 22, 2004, putting by this way into action the only national agreement referring to the climate change.

Giving these countries more (sink) allowances effectively relaxed the emissions constraints negotiated previously in Kyoto. These changes reduced the environmental effectiveness of the Protocol and illustrate the potential trade- offs between participation incentives and the environmental outcome of an international agreement. This may hint at a key consequence of the Kyoto agreement: it may not achieve high participation and compliance while reducing emissions substantially. For example, while Canada has ratified the agreement, it has signaled its intention to count exports of "clean energy" to the United States towards its emission reduction obligations. This accounting violates the treaty, suggesting that compliance may prove to be a significant problem for the Kyoto Protocol, even if the agreement enters into force[57].

The Kyoto architecture can be summarized as including four elements: ambitious, short-term reduction targets for industrialized countries; no emissions obligations for developing countries; flexibility for countries to achieve their commitments through market- based mechanisms; and non- compliance sanctioned with a penalty (not yet binding) linked to commitments in subsequent periods.

Environmentalists have supported the Kyoto Protocol partly because it has been "the only game in town" and partly because of the expectation that, with time, the emission limitations achieved by this agreement can be strengthened[58]. The agreement, however, will not achieve substantial mitigation, in the short run or in the long term, partly because it fails to promote participation and compliance. This is evident by the United States withdrawal from the agreement, the effective prohibition on the adoption of emissions commitments by developing countries, and the weak self- enforcement regime.

The lack of any enforcement measure is the most important drawback of the Kyoto Protocol. Given the demanding abatement targets agreed under the Protocol and due to the inherent instability of any transfer scheme (CDM, JI and Permit Trading) this shortcoming is

[57] See Aldy J. E., et al (2003), pg 9.

[58] Indicative is the warning of the United Nations that in order to eliminate the threat of climate changes a reduction of greenhouse gas emissions in the order of 50-70% in the following decades is required. Thus, it is clear that the Kyoto Protocol is only a first necessary step towards the establishment of a more effective solution.

particular serious. Other factors associated with the problem of global warming make this shortcoming even more important.

First the effects of global warming as well as expected abatement costs are uncertain by their nature. Second, political stability in developing countries and some countries of the former Soviet Union is relatively low. Third, the problem of unemployment is on the top agenda of most governments in Europe, whereas environmental issues have become less important. Consequently, all these factors imply that governments discount time much which is a source of instability.

Another source of instability is the low rate of detecting non- compliance which has to be expected as a result of the shortcomings of the monitoring system as mentioned. The only factor which may work in favor of the Protocol is the frequent monitoring through the expert panel based on the annual inventories submitted by the signatories.

The fact that enforcement measures have to be established via amendments which have to be agreed upon by consensus does not leave room for much hope that such measures will be implemented in the future. Moreover, any party foreseeing that it might not be able to comply with its target has always the option not to ratify the amendment and therefore the sanction procedures will not apply to the free- rider.

A general problem which arises is that even if sanction measures were established in the future, any non- complying Party can withdraw from the treaty within one year. This is unnecessarily short interval basically leaves not much leeway to design credible sanction procedures. It implies that possible sanctions may not endure longer than a few months and must be very soft so as not to induce a country from leaving the agreement.

Furthermore, recent studies emphasize the fact that without the US contribution, no effective emission control can be achieved[59]. In particular, in addition to meaning a straightforward reduction of emission abatement, the US defection will induce a whole chain of reactions. With the largest permit demander dropping out, the demand for GHG emission permits has fallen, which implies a lower than expected carbon price. This lower price reduces the expected costs of complying with the Kyoto Protocol in the remaining Annex II countries, but it also lowers their total amount of emission abatement through leakage effects.

Besides, the incentives to undertake environmental- friendly R&D and technological innovation also decrease. As a consequence, (i) the environmental effectiveness of the Kyoto Protocol is compromised; (ii) the incentives to abate emissions and invest in climate friendly

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[59] See Buchner and Carraro (2004), pg 5.

technologies are substantially lowered in all countries and (iii) in climate negotiations, the bargaining power of permit suppliers, notably Russia[60], have considerably increased.

Thus the Kyoto Protocol's architecture has been criticized on a variety of grounds. In response to the perceived flaws in the agreement and in response to uncertainty regarding the agreement's future given the declared non- participation by the United States, a variety of alternatives have been proposed. These proposals have been advanced in venues ranging from one- page editorials to book- length manuscripts[61].

[60] The Russian Federation is not only an important seller of emission permits, but also is the largest seller of gas to the European market.

[61] For more details see Aldy et al (2003) pg 10-17 and Barrett and Stavins (2002), pg 5-8.

3. PERMITS

A. GENERAL THEORY OF TRADABLE PERMITS

3.A.1 Introduction

The starting point for environmental policy design is the definitions of the unregulated market equilibrium and the social optimum. A partial equilibrium approach is usually adopted, with competitive markets, full information, no international trade and static conditions regarding the characteristics of the pollution. Thus environmental pollution in the static model is assumed to be of the flow or fund type. For this type of pollution, the assimilating capacity of the environment is such that it does not allow the accumulation of pollutants. This pollution generates damages only in the period emitted and not in subsequent periods. Examples of fund or flow pollution include smoke, noise, organic pollutants that can be transformed by bacteria into substances that are not harmful, and so on.

Considering flow type pollution allows for the use of a static analytical framework that greatly simplifies exposition. Thus the only distortion considered in the starting model is the environmental externality. This implies that only one instrument is required to correct the distortion. When more distortions are included along with the environmental externality, such as informational asymmetries or market imperfections, then more complex instruments become necessary.

But given the sub optimality of the unregulated competitive markets, the social planner can correct this distortion in the full information competitive context using a number of environmental policy instruments which internalize external social damages.

The design and application of environmental policy is an issue of great importance, at both the level of applied research and the level of applied policy- making. It is well known that from the economists' point of view, environmental policy is the case of analyzing externalities and market failure, issues thoroughly examined in microeconomic theory.

The type and the structure of policy instruments used to design environmental policy in practice are founded on the theory of environmental policy developed mainly in the 1970s and 1980s. However, the continuing in- depth analysis of the nature of specific environmental problems and the quest for ways to deal with important issues such as climate change or agricultural run- off, along with the continuous interactions of environmental economics with areas such as dynamic investment theory, industrial organization and international economics, has produced a number of important extensions to the basic environmental theory framework.

These extensions have not only helped us to better understand existing environmental problems, but also have made it possible to analyze new problems and examine the design of environmental policy under various assumptions about issues such as the type of market structure, the distribution of information or the time horizon of the problem[62].

Environmental pollution generated by the industrial sector of the economy, calls for specific policy measures that could induce individual polluters (firms) to behave in a way that would result in the socially desirable level of environmental pollution.

Environmental policy instruments can be divided into two broad categories: economic incentives or market- based instruments, and direct regulation or command and control approaches. Following the OECD classification, economic instruments include environmental or emission charges or taxes, marketable or tradable emission permits, output taxes, deposit-refund systems, performance bonds and voluntary agreements. Along with taxes, the case of subsidies can also be included. On the other hand, command and control approaches include the use of limits on output, inputs, emissions or technology at the firm level. The polluting firms are required to set outputs, inputs or emissions at some pre- specified level, or they are required not to exceed certain predefined levels.

3. A.2 The Concept of Tradable Permits

Tradable Emission Permits (TEPs) are only one of several possible instruments designed to encourage economics agents to internalize the environmental externalities for which they are responsible. Marketable emission permits represent a system of tradable property rights for the management of environmental pollution. They involve the determination of a total level of allowable emissions and then distribution of these permits to the firms. After their initial distribution, permits can be traded subject to a set of prescribed rules.

Internationally, under such a system, each nation would be allocated a target level of greenhouse gas emissions, and the nation would then distribute permits to emitters such that the total annual emissions allowed by the permits would not exceed the nation's target.

[62] See Xepapadeas A., (1997), pg 1.

To achieve this goal, economic instruments try to inform these agents of the consequences of their actions, either by rewarding them for positive actions, or by penalizing them for negative actions.

The idea of using tradable permits to control pollution emerged from a theoretical debate over the economics of externalities. Tradable or marketable emission permits were first proposed by Crocker (1966) and Dales (1968) and represent a system of tradable property rights for the management of environmental pollution[63]. The ideal Trading Scheme will have numerous buyers and sellers with a wide variety of marginal abatement costs, with none having sufficient market power to influence prices or quantities offered.

It was argued that a world- wide tradable- permits system could be an effective way of advancing the interests of developing countries in harmony with the global community's interest in protecting the atmosphere, provided that permit entitlements were allocated in such a way that the resulting rents accrued mainly to poor countries[64]. Permit trading provides a more flexible means to achieve air quality objectives, in theory minimizing the overall cost of emission reductions[65].

Tradable permits address the common problem by rationing access to the resource and privatizing the resulting access rights. The first step involves the determination of a total level of allowable emissions. For fisheries this would the total allowable catch. For water supply it would involve the amount of water that could be extracted. For pollution control it typically specifies the aggregate amount of emissions allowed in the relevant control region. This limit defines the aggregate amount of access to the resource that is authorized.

These access rights are then allocated on some basis to potential individual users. Depending on the specific system these rights may be transferable to other users and/ or bankable for future use. Users who exceed limits imposed by the rights the hold face penalties up to and including the loss of the right to participate.

[63] See Xepapadas (1997), pg 17.
[64] See Bertam G., (1992), pg 410
[65] Applications of this approach have spread in many different types of resources and many different countries. A resent survey found 9 applications in air pollution control, 75 applications in fisheries, 3 applications in managing water resources, 5 applications in controlling water pollution and 5 applications in land use control.

3. A.3 The Allocation of Allowances

In the global case the objective is to maximize the sum of utilities of individual countries subject to the given level of allowable emissions. Efficiency requires equalization of marginal abatement costs with the price of the permit. However, marginal cost equalization is efficient if marginal social valuation of consumption is equalized across countries. Therefore trading is efficient under marginal social valuation equalization, but equalization is possible only under redistribution of wealth; therefore there are a finite number of initial allocations that leads to equalization of social valuations. Thus the initial allocation of permits affects the efficiency properties of the permit system. So, unless there is some other instrument that will take care of distributional issues, an arbitrary chosen permit allocation does not ensure efficiency.

The initial allocation of international permits is perhaps the most controversial aspect of a tradable permits system. Whether consistent with efficiency or not, has to be determined by some principle. This is an important issue since in the international problem there is no supranational authority to decide on the distribution of permits in the way that the environmental regulator in the domestic case, can decide about grandfathering or auctioning the permits. Three methods of permit allocation are possible, each with differing implications in terms of economic efficiency and equity:

- Free allocation by criteria of:

Grandfathering – Refers to an approach where allocation is based on some historical emissions or activity levels. This type of allocation makes transition from command and control systems acceptable to existing sources, since it leaves them no worse- off. Under grandfathering, existing sources have only to purchase any additional permits they may need and above the initial allocation.

Performance standards – The allocation permits is based on current or historical ratios, or on optimal benchmark emission factors.

- Auctioning

Auctioning makes permits available to everyone on the same basis. It reveals the true preferences of the agents involved, and would have the merit of dispensing with the need for prior agreement on emission quotas. This approach may meet fierce resistance, however, and may result in a sub- optimum situation if there is a wide disparity between the financial capacities of the agents taking part in the auction.

There is also the possibility of a mixed system, where a certain proportion of permits is distributed free of charge, while the rest are auctioned. Whatever the initial allocation, the transferability of the permits allows them to ultimately flow to their highest valued uses. Since those uses do not depend on the initial allocation, all initial allocations result in the same outcome and that outcome is cost effective.

3. A.3.1 Criteria for Evaluating Alternative Allocation Approaches

Criteria for evaluating alternative approaches are divided into two basic categories. The first category relates to efficiency criteria, notably the minimization of overall compliance costs, but also including the interactions between the initial allocation mechanism and the efficiency of related markets or the overall economy. The second category addresses distributional criteria, including impacts on sectors, on segments within sectors (e.g. producers, consumers) and other distribution- based criteria.

1.Efficiency considerations and interactions

- Allowance or emissions market efficiency. This criterion relates to the overall cost of meeting the cap. Does the mechanism encourage the minimization of the overall costs of control to meet the cap? Are administrative costs likely to be substantial and thus compromise the cost savings from trading?
- Product market distortions. This criterion relates to effects due to existing or induced inefficiencies in product markets and the possibility that these inefficiencies would compromise the cost- savings from emission trading. This category also includes product market inefficiencies induced by the initial allocation mechanism, such as concerns that grandfathered allocations would distort trade among Member States.
- Tax distortions. This criterion relates to the inefficiencies in the tax system (e.g. distortions in the choice between work and leisure due to the income tax) and the possibility that auction revenues would allow these distortions to be reduced.

2.Distributional considerations.

- Controlled sector burdens. This criterion relates to the overall impacts on the sectors controlled under the cap- and- trade program. The key distinction here is between methods that allocate allowances initially to these sectors, on the one hand, and the auction method, which would require all allowances to be purchased, on the other hand.
- Burdens and benefits to major segments of the economy, including producers, consumers and taxpayers. This criterion involves assessing the effects of the initial allocation mechanism on product markets as well as on government tax revenues. One issue involves

assessing the extent to which owners of existing plants - who bear what might be termed "stranded costs" as a result of a new requirement to reduce CO_2 emissions-, would be compensated for the costs they bear. Another issue concerns the effects of the allocation approach on product prices (and thus on the costs borne by consumers rather than producers). Also included here would be a consideration of how plants or firms that have undertaken "early action" to reduce emissions are affected.

In addition the empirical investigations allows for considering several other criteria among different Member States.

- Feasibility. This criterion relates to whether the data to implement a particular approach are or would be available and whether proxies are likely to be accurate.
- Relative sector effects. This criterion relates to the relative gains or losses to various sectors under alternative allocation mechanisms.
- Relative plant effect. This criterion relates to the relative gains or losses to individual plants under alternative allocation mechanisms.

With regard to efficiency criteria, auctions and grandfathering provide the best incentives to minimize compliance costs- that are; they both encourage efficiency in the allowance market- assuming that the allowance market is competitive and that there are no pre- existing distortions in the product market.

Furthermore, auctioning generates revenues for the country, which could be:

- recycled into the economy by, for example, reducing existing taxes
- used as compensation to those bearing the burden
- used to subsidize research on environmental issues.

Grandfathering reduces the incentive for regulated firms to develop environmental innovations, as compared to auctioning. This is because environmental innovations reduce the value of the permits, thus the wealth of permits- holders. Furthermore, grandfathering may create a bias against new firms entering product market since existing firms get their permits free while new firms must buy them. Such a problem may arise if the capital market is imperfect and/ or if existing firms benefit from market power on the permits market. In both cases, these firms may be able to use their permits to drive their potential competitors out of the market.

3. A.4 Credit and Cap- and- Trade Programs

In general tradable permit programs fit into one of two categories: *a credit program* or *a cap- and- trade program*[66]. The credit program involves a relative baseline. With a credit program an individual access baseline is established for each resource user. The user who exceeds legal requirements, say by harvesting fewer fish than allowed or emitting less pollution than allowed, can have the difference certified as a tradable credit.

The cap- and- trade program involves an absolute baseline and trades allowances rather than credits. In this case a total resource access limit is defined and then allocated among users. Air pollution control systems and water have examples of both types. Fisheries tradable permit programs are all of the cap- and- trade variety.

The baseline for credits is provided by traditional technology- based standards. Credit trading presumes the preexistence of these standards and it provides a more flexible means of achieving the aggregate goals that the source- based standards were designed to achieve.

Allowance trading, used in the US Acid Rain Program assigns a pre- specified number of allowances to polluters. Typically the number of issued allowances declines over time and the initial allocations are not necessarily based on traditional technology based standards; in most cases the aggregate reductions implied by the allowance allocations exceed those achievable by standards based on currently known technologies.

Despite their apparent similarity the difference between credit and allowance- based trading systems should not be overlooked. Credit trading depends upon the existence of a previously determined set of regulatory standards. Allowance trading does not. Once the aggregate number of allowances is defined, they can, in principle, be allocated among sources in an infinite number of ways. The practical implication is that allowances can be used even in circumstances where a technology- based baseline either has not been, or cannot be, established or where the reduction is short- lived rather than permanent.

The other major difference is that cap- and- trade programs generally establish an upper aggregate limit on the resource use, while the credit programs establish only an upper limit for each user. In the absence of some other form of control over additional users, an increase in the number of users can lead to an increase in aggregate use and the eventual degradation of the resource.

[66] See Tietenberg T., (2002), pg4.

3. A.5 Monitoring and Enforcement

Regardless of how well any tradable permit system is designed, noncompliance can prevent the attainment of its economic, social and environmental objectives. Noncompliance not only makes it more difficult to reach stated goals, it sometimes makes it more difficult to know whether the goals are being met.

Although it is true that any management regime raises monitoring and enforcement issues, tradable permit regimes raise some special issues. One of the most desirable aspects of tradable permits, their ability to increase the value of the resource, is a two- edged sword because it also raises incentives for noncompliance. In the absence of an effective enforcement system, higher profitability from cheating could promote illegal activity. Insufficient monitoring and enforcement could also result in failure to keep a tradable permit system within its environmental limit.

Monitoring and verification will always be a costly business. And at this point raises the question: Do monitoring and enforcement costs increase under tradable permit programs? The answer depends both on the level of requirement enforcement activity (greater levels of enforcement effort obviously cost more) and on the degree to which existing enforcement resources are used more or less efficiently. Higher enforcement costs are not, by themselves, particularly troubling because they can be financed from the enhanced profitability promoted by the tradable permit system[67].

-monitoring

Every monitoring system must identify both the information that is needed to monitor the operation of the tradable permit program ad the management component that will gather, interpret, and act on this information. Data should also be collected on transfers so that monitoring and analysis of the market can take place. Effective monitoring systems are composed of data, data management and verification components.

In general, the smooth implementation of a tradable permit program requires two different kinds of monitoring data. First, periodic data on the condition of the resource are needed to evaluate the effectiveness of the program over time. These data are used as the basis for adjusting environmental limits as conditions warrant. Second, managers need sufficient data to monitor compliance with the various limitations imposed by the regulatory system.

-enforcement

[67] See Tietenberg T. (2002), pg 11.

A successful enforcement program requires a carefully constructed set of sanctions for noncompliance. Penalties should be commensurate with the danger posed by noncompliance. Penalties that are unrealistically high may be counterproductive if authorities are reluctant to impose them and individuals (or firms) are aware of this reluctance. Unrealistically high penalties are also likely to consume excessive enforcement resources as those served with penalties seek redress through the appeals process.

3. A.6 Criteria for determining the success of a TEP

In theory, three basic criteria should be used to access the success or failure of a TEP system[68]:

- achievement of environmental objectiveness,
- minimization of economic costs,
- contribution to technological innovation.

The first of these criteria is precisely what makes a TEP system intrinsically superior to an administrative charge, or to a taxation approach. In terms of economic costs, first one must not look solely at the costs of reducing emissions that are borne by firms, but also at the cost of managing the entire system (information, monitoring, policing, auditing, etc.). These costs are far from negligible. Above all, should the cost comparison be made with the cost of the regulatory policy that predated the system, or with the cost of other forms of regulation, such as negotiated standards, charges or removing market imperfections.

As a general rule all the technical measures that needed to be taken when setting up a TEP market should follow the same basic requirement: the system should be simple, predictable and manageable, since these are the qualities that are based on experience and will ultimately make it more credible.

Several additional precautions must also be taken in the launching and management of the TEP system. The most important of these are[69]:

i) The first hurdle that that must be crossed is that of the initial allocation of rights. The objective should be to limit any strategic behavior among potential recipients of these rights. This should be done by sticking closely to simple rules of allocation that can all recognize as being intrinsically fair, and by avoiding the pitfall of granting too many ad hoc exceptions. The

[68] See Hourcade J.C. and Baron R., (1993), pg 22
[69] See Hourcade J.C. and Baron R., (1993), pg 25

fairness of this initial allocation of rights is important, not only for the initial acceptability of the system but also for its subsequent operation. It is extremely difficult to alter the initial allocation at a later date without damaging vested interests. Furthermore, any unexpected amendments will undermine the overall degree of confidence in the system.

ii) Predictability and manageability are not automatically compatible with each other. For instance, if the authority wishes to have a system that can be readily adaptable, it should issue short- term permits. If they do this, however, they will restrict the agents' capacity to plan ahead, and thereby discourage long- term innovation. From the standpoint of the agents, predictability goes hand in hand with giving TEPs a market value, a prerequisite, for giving a financial incentive to reducing emissions. A balance therefore needs to be struck between these two parameters, because we are again faced with the fact that the authority cannot change the rules later without undermining the agents' confidence in the system. One immediate consequence of meeting both these criteria is that it becomes extremely important to prevent evasion.

iii) The introduction of banking and trading system means that the same right might be sold several times at completely different periods. This is why all experts agree that stiff penalties must be applied to actors who fail to respect quota restrictions on the number of rights they are entitled to possess at a given point in time.

iv) The need for the market to be open enough to attract as many players as possible means that the accounting and monitoring system required will be significant. Even when the system is first being negotiated, the parties concerned need to have at least some idea of what the marginal cost curve for emission reductions looks like. The regulatory authority cannot propose an acceptable level of reduction without making some kind of a trade- off between the cost to the economic sectors involved and the quality of the environment.

v) Overall, the monitoring and compliance control procedures that need to be introduced to implement an emission permit system are likely to be relatively sophisticated. There is an inevitable trade- off between the "moral need" for comprehensive monitoring of the level of emissions and the "administrative need" to reduce monitoring costs. Experience shows that attempts to merely audit compliance may lead to additional environmental damage, this approach inevitably encourages cheating of one form or another.

vi) Another important precondition involves the absence of large uninternalized externalities. The presence of uninternalized externalities would imply that maximizing the net benefits of permit holders would not necessarily maximize net benefits for society as a whole even with a fixed environmental target. For example, fishermen might catch he specified amount of the covered species, but they might use gear that destroys other components of the marine ecosystem. Polluters that reduce a covered pollutant by switching inputs could well increase emissions of another unregulated pollutant. The regulation could serve to protect one environmental resource at the expense of another.

Final, the use of permits needs to be made compatible with other emissions legislation. The government must also ensure that permits do not act as a cap on growth, particularly for energy intensive sectors, by carefully analyzing the potential for economic efficiency improvements in the participating sectors.

3. A.7 Advantages and Disadvantages

The main advantage of tradable- permit regimes, is their ability to achieve environmental aims with a minimum of bureaucratic apparatus. The central problem with most such schemes to date has been that the "licensee to pollute" has been granted to firms which were already major polluters, with the result that the rents associated with a growing scarcity of pollution entitlements fell into the hands of those firms- a result with obvious equity problems, which provides the wrong incentives both to polluters and others.

Thus any tradable permit system should be designed in such a way as to incorporate the principle that polluters should pay, through the mechanism of being obliged to buy at least part of their right to pollute. A second basic principle is that the large flows of rents generated by those payments should be channeled directly from polluters to the owners of the property right, without passing through the hands of large international agencies on the way.

One big problem is the possibility that an otherwise desirable tradable- permits program might be "captured" by the large industrial powers as a means of advancing their own interests against the rest of the world community. Whether tradable permits at the global level are a workable idea or not hinges critically upon the property- right assumptions which underlie any program. The choice of property- rights assumption should be guided by the principle of seeking the highest possible degree of incentive compatibility to induce national governments to co- operates[70]. One key requirement for a workable international scheme would be that permits not be allocated preferentially to existing polluters[71].

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[70] The rationale for the marketable permits approach stems from the work of Coase (1960). What has become known as the Coase Theorem states: externalities can be eliminated effectively through market transactions if

A tradable permits system directly links economic incentives to the sources and sinks of greenhouse gases. However, the system only works if the administrator of the permits system can quantify those emissions or absorptions. Without such quantitative information it is impossible to identify violators- except possibly in egregious cases- and the permits system will fail to optimally achieve its economic and environmental objectives. Indeed, without adequate information the permits system may even be counterproductive: the world may think it has tackled global warming when the problem actually remains unimproved.

Emission trading may increase the threat of hot spots in two main ways. First, trades may create unacceptably high local concentrations near sources that have acquired permits as an alternative to further control. Second, permits may allow the long range transport of emissions to increase, thereby increasing deposition problems. This concern depends of the environmental problem. It may be important concerning ozone or acid rains. It is much less when addressing climate change where the GHG accumulation in the atmosphere determines the global warming potential. However, reducing CO_2 emissions from fossil fuels usually leads to a reduction in local pollutants; hence localization of emissions does matter, although indirectly.

3. A.8 Imperfectly Competitive Markets

It is well known that a competitive permits market achieves the cost minimizing distribution of abatement effort among the polluting firms for a given reduction in emissions.

In the case of imperfectly competitive markets, permits system might not lead to the optimization of the resource allocation problem.

As far as it concerns the presence of imperfectly competitive product markets it is indicated that trading of emission permits has two effects[72]. First, it achieves cost-minimization of emissions control, effort by equalizing marginal cost of abatement among firms; a direct consequence of competitive permits market. Second, it redistributes production among firms due to imperfections in product markets and firm- specific differences in emissions control technologies. The first is clearly a welfare increasing effect, while the second might be welfare decreasing if the inefficient firms are the ones that gain market share. The

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property rights can be assigned, regardless of who receives the rights (assuming no significant transaction costs or income effects).

[71] See Bertram G., (1992), pg 436

[72] See Sartzetakis E. S., (1997), pg 66.

redistribution of market shares among firms is controlled by the permits market mechanism and the welfare- increasing effect dominates.

In the presence of market imperfections, trading of emission permits induces excessive output redistribution from the more to the less efficient firm in controlling emissions. Output redistribution adversely affects industry's profits. Trading of emissions permits is optimal only when there is no redistribution of profits among firms in the industry. The extend of profits redistribution determines whether trading of emission permits yields higher social welfare relative to a command and control system that prohibits trading of permits.

The existence of market power in the permits market will have a much bigger adverse effect on social welfare than the output redistribution effect. In the case of dominated permits markets, social welfare decreases as a result of emission permits trading in most cases. The extent to which market power affects social welfare depends on the initial allocation of emission permits. Thus when the abatement cost differs substantially among the regulated firms, the allocation of emission permits should be such as to prevent strategic behavior in the permits market.

3. A.9 Transaction Costs

In general transaction costs are ubiquitous in market economies and can arise from the transfer of any property right because parties to exchanges must find one another, communicate, and exchange information. There may be a necessity to inspect and measure goods to be transferred, draw up contracts, consult with lawyers or other experts, and transfer title. Depending upon who provides these services, transaction costs can take one of two forms, inputs of resources- including time- by a buyer and/ or a seller or a margin between the buying and selling price of a commodity in a given market.

Hence transaction costs can be thought of as the direct financial costs of brokerage services.

We can identify three potential sources of transaction costs in tradable permit markets[73]: (1) search and information; (2) bargaining and decision; (3) monitoring and enforcement. The first source, search and information, may be the most obvious. Due to the public- good nature of some information, it can be underprovided by markets. Brokers step in, provide information about firm's pollution- control options and potential trading partners, and thus reduce transaction costs, while absorbing some as fees. Although less obvious, the second source of

[73] See Stavins R. N., (1995), pg 134.

transaction costs, bargaining and decision, is potentially as important. There are real resource costs to a firm involved in entering into negotiations, including time and/ or fees for brokerage, legal, and insurance services. The third source of transaction costs- monitoring and enforcement- can also be significant, but these costs are typically borne by the responsible governmental authority and not by trading partners, and hence do not fall within our notion of transaction costs incurred by firms.

There are two sets of circumstances in which transaction costs might be particularly high: (1) transfer is expensive for technological reasons; and (2) institutions are designed to impede trade. Both apply in the tradable- permit context and in either case, transaction costs in the form of direct, financial costs of trading are frequently the result.

B. PERMITS IN KYOTO

The Emission Trading Regime will first be introduced on a phased basis. The pilot phase will start in 2005 until 2007 inclusive. All Member States of the European Union will be required to impose binding, absolute caps on CO_2 emissions of facilities in energy activities, the production and processing of ferrous and non- ferrous metals, the mineral industry and the pulp, paper and board production. The first trading period until 2007 is seen as a test for the second period from 2008 – 2012 that coincidences with the first Kyoto commitment period.

According to the EU emission trading proposal the allocation of emission allowances will be based on grandfathering in the first commitment period and the price will be a function of supply and demand as in any other free market.

Each share would entitle the holder to emit a specified proportion of the global budget for each year of the permit's life. In the case of global carbon emissions, the numbers are convenient: each permit is the equivalent of one tone of CO_2 emissions.

Emission permits are licenses and so governments should explicitly recognize other countries' permits.

The allocation of permits to the ETS is subject to the so- called *National Allocation Plan (NAP)* that according to the EU directive, each member has to prepare before the beginning of each of the two trading periods from 01/01/2005- 2007 and 2008-2012. For the first period the NAP was to be submitted by the end of March 2004. In the NAP each country has to determine the total quantity of allowances in the ETS and to decide how it intends to allocate them to individual operators[74].

For the three year period beginning the first of January 2005, member states will allocate allowance for free. For the five year period commencing on the first January 2008, member states shall allocate at least 90% of their allowances for free. For the three year period beginning the first of January 2005, each member shall decide upon the total quantity of allowances it will allocate for that period and the allocation of those allowances to the operator of each installation. This decision shall be taken at least three months before the beginning of the period and be based on its National Allocation Plan. For the five year period beginning the first of January 2008, and for each subsequent five- year period, each member state must again decide upon the total quantity of allowances it will allocate for that period. However for these subsequent periods this decision must be taken at least twelve months before the beginning of the relevant period and it must be based on the National Allocation Plan. This allows countries to adjust the allowances after the first three years, presumably based on progress in complying with the national assigned amount.

The allocation of allowances must be consistent with the technological potential of installations to reduce emissions. No allowances should be allocated to cover emissions which would be reduced or eliminated as a consequence of Community legislation on renewable energy in electricity production. No discrimination against or in favor of particular companies or sectors, information on how new entrants will be treated, and how the public will be engaged.

The directive also mentions explicitly that the total quantity of allowances has to be consistent with the Kyoto emission targets of each country and with the assessments of actual and projected progress towards fulfilling the member states contributions to the Community's commitments. Within three months the Commission can reject the plan and ask for changes to be made. In a final step, each country has to take its final decision on the NAP.

To help the members to establish the NAPs the EU Commission has published a "Non-Paper" in which a step by step process to develop a NAP is outlined. The paper suggests that the first step should be to establish the share of the total allowable emissions under the Kyoto Protocol that will be allocated to the installations covered by the trading scheme in a top- down economy- wide analysis. In a next step it is then suggested to collect data from the single installations and companies in a bottom up approach. The allocation of permits to each

[74] See Klepper G. and Peterson S. (2004), pg 5.

individual sector is finally determined based on current, historical or average emissions for a certain year.

Each allowance should provide: the name and address of the installation involved, description of the gases emitted and the activities that take place, the method and the frequency of monitoring, claims for the application of the emissions, obligation to return, every first quarter of the year, of the rights that are equivalent to the total emissions of the previous year.

Allowances shall be valid for emissions during the period for which they are issued. Essentially this means that banking within the relevant period is permitted, but not borrowing[75]. This raises the issue of the extent, if any, to which allowance holders have a property right. The challenge is to provide sufficient security of tenure that allowance holders will trade, but to make it clear that permits are not property rights, and that the government still holds natural and environmental endowments in trust for the people.

The Kyoto Protocol allows banking (except, since the Marrakech accords, for sink credits), which may encourage early reductions beyond the Kyoto target, while borrowing as a flexible mechanism, has not been allowed, because of ensuing difficulties in resolving environmental problems. The problem of banking is that this may imply some temporary hot spots in the future if some countries simultaneously make use of this option. Moreover, a government may postpone emission reductions, promising to clear its account later. If governments act myopically or are not reelected, temporary deficits may become permanent[76].

C. EU AND KYOTO PERMITS

3. C.1 Institutional Framework

The Emission Trading scheme in prospect in the European Union will be the first trans-national greenhouse gas emissions trading scheme in the world. With the participation of the European Economic Area (EEA) countries and with the forthcoming EU enlargement, 30 countries could be involved in this scheme by 2012. The main goal of the EU emissions trading scheme is to help EU Member States achieve compliance with their commitments under the Kyoto Protocol and reduce the welfare costs of meeting the European emission targets.

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[75] Banking is the carrying over of unused allowances from one commitment period to the next while borrowing refers to the using of emission allowances from a future commitment period.

[76] Boemare and Quirion (2002)

Under European Union law, the European Commission is responsible for making proposals, which are then decided upon by the council of Ministers – on a "qualified majority" basis in this case- representing the 15 Member State governments, and the European Parliament. The European Parliament also proposes amendments to the original Commission proposals. In terms of finalization, what remains to be decided is whether the Parliament will decide that the Directive as agreed by the council of Ministers is sufficiently close to its desires to be acceptable, or whether a conciliation process must be initiated, which involves a formal effort to reach compromises on points of disagreements.

The Commission in October 2001 adopted a major package of initiatives to combat climate change. This package includes a proposed Directive on GHG emission trading as well as a proposal for the EC to ratify the Kyoto Protocol and a Communication setting out further methods for reducing greenhouse gas emissions beyond the Directive on emission trading.

The proposed Directive provides the structure for an internal European Union trading program. As noted by the Commission, emissions trading will reduce the cost of emission reductions by encouraging these reductions to be made where they are at least costly, while at the same time achieving a pre- determined emission reduction from the activities covered by the trading program. The proposed Directive is designed to provide an EU –wide cap- and- trade market for GHG emissions at various plant- level sources that is free of distortions that might arise from separate Member State emissions trading schemes. The Directive entered into force in October 2003 and is part of the EU's general policy on climate change and, as such, does not depend on the entry into force of the Kyoto Protocol. The scheme will start in January 2005.

An important element left to Member States (with approval by the Commission) is the initial allocation of allowances (i.e. rights to emit a tone of CO_2 or other GHG). Initial allocations provide the starting points for cost-reducing among facilities covered by the cap- and- trade program. Setting the initial allocation typically has been one of the most contentious issues in developing a workable cap- and- trade program.

Based on the results of a recent study conducted for the commission to assess the costs of reducing greenhouse gas emissions, the total value of the allowances covered by the program would be nearly €30 billion annually (substantially greater than the estimated control costs of €3.7 billion - €7.5 billion)[77]. How these allowances are distributed initially is likely to be a matter of considerable concern to the affected parties. In addition, the mechanism used to set

[77] See Harrison D., and Radov D.B., (2002), pg ES-1.

the initial allocation can affect the efficiency of trading- as well as the impacts on various segments of society- and thus the overall costs of achieving the emissions cap.

But what has happened in less than five years to move emissions trading towards the top of the policy agenda in Europe? First, the Climate Change Unit which is proved to be a potentially powerful mechanism for helping to achieve agreed targets. Secondly, some elements of industry in some Member States see it as appositive alternative to carbon taxes, and non governmental organizations, while not vehement in their enthusiasm, have no been vehement either in their opposition. Thirdly, the fact that it is included overtly in the Kyoto Protocol as a flexible mechanism has forced all parties to give the instrument consideration.

3. C.2 Three Pathways to European Trading in GHG Permits

Since the adoption of the Kyoto Protocol three major pathways are available to introduce European trading in GHG permits as one of the policies to implement the commitments under the Kyoto Protocol[78]:

- Top- down UN scheme,
- Collection of bottom- up Member States schemes,
- Regional EU- level scheme.

The first pathway is to develop the complete design at the UN level in the context of the negotiations of the Kyoto Protocol among the international community of nations. In its extreme version this requires that all design choices, including e.g. the selection of participating sectors and companies, level of the overall cap, allocation methods and exact rules in any one country, need to be agreed by about 180 countries in a UN process based on consensus.

The advantage of following this pathway is that a very coherent system will be put in place with a maximum degree of harmonization in all choices and no forward compatibility problems at all. The major disadvantage, which renders this option in its pure form rather theoretical, is the fact that the consensus principle in the international negotiations will create endless delay and probably weak compromises that may not result in a robust system.

The second pathway is the very opposite of the UN-scheme. Under this alternative all the design choices are taken by sovereign Member States of the European Union in the set- up of national trading schemes at company level. This implies that emission trading is treated as a

[78] See Zapfel P., and Vainio M., (2002), pg 2.

domestic policy not constrained in its conception in any way by the Kyoto Protocol. Of course it could be constrained by other international and European law and policy.

The advantage of this route is the maximum flexibility given to individual Member States in taking into account national circumstances and preferences. In addition, in the early phase of implementing a new instrument, competition between various national solutions can spur learning effects. However, following this pathway is likely to result in a set of national schemes that may not be compatible in some crucial choices so that the linking of these schemes into a Common European market in GHG permits will be complicated if not made impossible, unless the one or other scheme or several are adopted. Such adaptation may be difficult, if Member States meet international political resistance to modify the features of their national trading schemes to allow EU- wide trading to take place.

Experience with emission or quota trading as a domestic or sectoral environmental policy instrument is more widespread. However, most applications have not been implemented in EU Member States or even on the European continent, but rather in other countries, most prominently the United States, the major proponent of emissions trading in the Kyoto negotiations.

The third pathway towards EU- wide trading in GHG permits is the most direct and possibly the most obvious route via a scheme designed at the level of the EU and implemented in EU Member States. This implies again that emission trading is treated as a domestic policy, this time at the EU level, not constrained by the Kyoto Protocol. Of course it could be constrained by other international law and policy. An EU level scheme can be designed respecting relevant European law and policy. An EU level scheme can be designed more or less prescriptive and one can harmonize or co- ordinate all design choices or only those seen as absolutely crucial for a smooth functioning of the EU- wide market.

The advantage of this route is that a minimum degree of co- ordination or harmonization is needed and many, if not all, of the interface problems related to domestic schemes are anticipated and avoided. While such a scheme can be put in place quicker than a UN scheme, European decision- making nevertheless requires usually more time than in the Member States. However, the possibility of engaging all Member States at once may outweigh the short- term advantage of quicker national decision- making.

High quality monitoring is essential to assure effectiveness of both compliance and trading systems. The Commission decision to start with the sole CO_2 reflects the importance given to monitoring. However, even for industrial CO_2 emissions, calculation using activity data, emission factor and oxidation factor is not without problems. The accuracy of current national inventories based on this method falls far short of what is needed for a trading scheme, so further guidance has to be provided at the EU level.

Compliance penalties seem to be set at a sufficiently high level: 40 € for each tone of excess CO_2 equivalent emitted for the first three years and 100€ afterwards, plus restoration of excess tons in the following year. Payment of the excess emissions penalty shall not release the operator from the obligation to surrender an amount of allowances equal to these excess emissions when surrendering allowances in the following calendar year.

The Emission Trading Scheme is a cornerstone in the fight against climate change. It is the first international trade system for CO_2 emissions in the world. It covers some 12.000 companies in the EU-25[79], representing close to half of Europe's emissions of CO_2. In large Member States some 1.000 to 2.500 plants are covered, while in most other Member States the number of plants covered tends to range from 50 to 500[80].

The ideal trading scheme will have numerous buyers and sellers with a wide variety of marginal abatement costs, with none having sufficient market power to influence prices or quantities offered. As initially proposed by the commission, the trading scheme was obligatory for the entities to which it applies. In the first phase, trading will be confined to carbon dioxide emissions from power station installations in excess of 20MW (except incinerators), oil refineries, smelters, manufacture of cement (more than 500 tones per day), ceramics including brick, glass, pulp, paper and board (more than 20 tones per day). These sources will comprise 4000 to 5000 installations. The chemical sector is excluded because its emissions of 26 million tones of CO_2 equivalent in 1990 are relatively modest, and the number of installations is relative high. Waste incinerators are excluded because of the complexities of measuring the carbon content of the waste material being burnt.

The Commission has no view on what the price of allowances should be. The price will be a function of supply and demand as in any other free market. Market intermediates already quote prices for small quantities of allowances offered or bid for. The Commission will not intervene in the allowance market. Should distortions occur, competition law would be applicable as with any other market.

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79 Combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper.

80 See http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/04/44&format=HTML

4. NATIONAL ALLOCATION PLANS IN EU

4.1 The Purpose of NAPs

The National allocation Plan (NAP) determines the total quantity of CO_2 emissions that Member States will grant to their companies, which can then be sold or bought by the companies themselves (allocation budget) and states rules to assign these allowances to the respective installations (allocation mechanism). The intent is to seek to ensure that no sector or installation is faced with a disproportionate cost for their share of meeting the country's Kyoto target, thereby minimizing the impact on national competitiveness.

To do so, each Member State must ex- ante decide how many allowances to allocate in total for the period 2005 to 2007 and how many each plan covered by the Emissions Trading Scheme will receive. The idea is that Member States limit CO_2 emissions from the energy and industrial sectors through the allocation of allowances, thereby creating scarcity, so that a functioning market can develop late and overall emissions are then really reduced.

Each Member State had to prepare and publish a national allocation plan by 31 March 2004 (1 May for the 10 acceding countries).

4.2 Criteria for the Assessment of an Allocation Plan

The assessment of the allocation plans is based on the 11 common criteria in Annex III to the Directive on Emission Trading[81].

The first criterion provides that the proposed total quantity of allowances must be in line with a Member State's Kyoto target. This means that a Member State should make sure that the allocations that they grant their plants will allow it to meet its Kyoto targets.

Of course, the Member State can and should also take other measures. Other sectors also generate greenhouse gas emissions: in the EU, transport is responsible for 21%, households and small business for 17% and agriculture for 10%. So, Member States can and should also take measures to reduce emissions in these sectors. In addition, Member States can plan to purchase emission credits through Kyoto's flexible project- based instruments Clean Development Mechanism (CDM) and Joint Implementation (JI) and international emissions

[81] See http://europa.eu.int/rapid/pressReleasesActin.do?reference=MEMO/04/44&FORMAT=html

trading under the Kyoto Protocol. CDM and JI allow governments to implement emission-reduction projects abroad and count the achieved reductions against their own Kyoto targets. JI projects can be undertaken in other industrialized countries with Kyoto targets, while CDM projects can be hosted by developing countries, which under the protocol have no targets.

All these measures and their projected results must be mentioned in the allocation plans. Under criterion 1 the Commission assesses whether the emission levels of the industries that participate in Emission Trading, alongside these other measures, will enable the Member State to meet its Kyoto targets. As only the combined effect of different policies and measures will allow Member States to achieve their targets, the Directive Speaks of the "path" to Kyoto. A number of criteria also ask Member States to assess emissions developments and potentials for reductions in all sectors.

In addition there are criteria that seek to ensure non- discrimination between companies and between the different sectors as well as compliance with the EU's competition and state aid rules. Other criteria relate to provisions in the plan for new entrants, the accommodation of early reduction efforts and clean technology.

In general the main provision of Annex III focuses on:

- Kyoto commitments
- Consistency with assessment of emissions developments
- Consistency with potential o reduce emissions
- Non- discriminating between sectors in determining the allocation of allowances
- Taking early action into account[82]
- Taking into consideration other environmental legislation
- Provision for new entrants
- Competition from outside the EU
- List of installations covered by the Directive
- Public consultation.

The Commission published guidance on the implementation of these allocation criteria in early January 2004. If the Commission finds that a plan is not in line with the criteria and the EU Treaty it can, in art or in full, reject it. If the Commission has not rejected any aspect of its plan, the Member State can proceed to take a final allocation decision. The Commission's decision has to be taken within three months from the date a Member State notifies a National Allocation Plan to the Commission.

[82] The Commission defines early action as "actions undertaken to reduce covered emissions before the NAP is published and notified to the Commission".

Any rejection of a National Allocation Plan means that the Member State may not proceed to implement the plan as it stands, i.e. may not allocate the number of allowances proposed. The Commission must give reasons in any rejection decision. These reasons will give guidance to the Member State on how to make the plan compatible with the allocation criteria.

The quantity of allowances a Member State may issue is governed by the 11 criteria. The Directive does not explicitly prescribe a given number of allowances, but each Member State must respect the criteria. This means that in practice their leeway is limited. If a Member State were over- generous in issuing allowances, not only would the plan probably be failing to comply with some of the allocation criteria, but the Member State would also miss out the opportunity to use the Emissions Trading Scheme as a tool to help it comply with Kyoto. And if too many allowances were issued, there would be no scarcity so no market would develop.

4.3 Steps Involved in Setting Initial Allocations

The following is a brief reference to the steps that a Member State should use to organize their development of initial allocations under a cap- and- trade program[83].

Firstly, each Member State has to decide the share of overall emissions allowed under the Burden Sharing Agreement that will be assigned to facilities in the sectors covered by the trading regime. The share can be determined in various ways:

-Historical share of overall emissions from covered sectors in a base year,

-Expected share of overall emissions from covered sectors under business- as- usual,

-Expected share of overall emissions in the target period under a least cost approach.

Member States may wish to consider relative trends (e.g. in sector growth) for both covered and non- covered sectors, as well as the potential for emissions reductions from these two classes of sectors. The more that is allocated to the trading sectors, the more non- covered sectors must bear the burden of emissions reductions to achieve overall Member State targets.

Secondly, the fraction of allowances that will be allocated free of charge versus the fraction auctioned to the highest bidders (unnecessary for 005-2007 under the current Proposed Directive) should be decided. The split between those allowances allocated without charge and those sold at auction can be fixed over the relevant period and/ or change over time (presumably on a pre- determined path).

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[83] Sew Harrison D. and Radov D. (2002).

Thirdly, each Member State has to decide how to organize the auction and how to use the revenues from auctioning (unnecessary for 2005-2007 under the current Proposed Directive). If some allowances are auctioned, the Member State must set up an auction and determine how its revenues will be used. There are many choices related to auction design including: sealed-bid (single- round) auction versus multiple- round auction, uniform prices versus multiple prices and government operation versus private operation. Auction revenues can be “recycled” back to bidders, used to reduce specific taxes or be put in general revenues.

Forth, the availability of data to implement potential options for distributing non-auctioned allowances must be determined. This is an important step as a Member State moves from theory to practice. Allocating to sectors and ultimately to individual facilities requires that data must be obtained or developed. The practical applicability of any particular approach depends upon data being available to implement it with sufficient credibility.

It is clear that the nature of the facility- level data differs across Member States; no single, publicly available EU-wide database currently provides plant- level information that can be used as a single foundation for allocations across all Member States. This is not however, an insurmountable obstacle. It should be possible for all Member States to develop the necessary plant- specific information using a combination of EU-wide information and data available in the individual Member State, perhaps supplemented by confidential (and verified) information from the sources. Indeed, this step represents an important collaborative process between government and private sectors.

Finally, each Member State has to determine the specific initial allocations of the non-auctioned allowances to each sector and to individual facilities. Based upon the data developed to implement the allocation program, several basic metrics could be used to allocate to sectors. Indeed, the same metric used to determine the overall share for the entire trading program could be used to allocate the non- auctioned share of allowances to each sector. Alternatively, sector shares can be determined through negotiations between the government and representatives of the sectors concerned.

For the basic allocations to individual facilities, several metrics have been used: emissions, production inputs (for example heat input) and production output. It should be noted that if emissions are used as metric for individual facilities, the sector- specific allocation may be unnecessary. If other factors are used, the sector split may be useful. Whatever metric is used can be applied to data in various years: single year, average of recent years or maximum value over recent years.

In addition to the basic metric- year formula for the plant- specific allocation, the Member State can add several variations: credits for "early action" (additional allowances for facilities that reduce emissions before the program begins but after baseline allocations are set), new source "set asides" (allowances for new sources) and bonus allowances for other emissions reduction projects. If the facility- specific allocations exceed the total under any formula, they can be adjusted so that the total to the sector (or the trading program) is not exceeded.

4.4 How Many Plans has the Commission Assessed so Far?

On 7 July 2004, the Commission concluded the assessment of a first set of eight plans. It accepted five plans unconditionally (Denmark, Ireland, the Netherlands, Slovenia and Sweden), and partially rejected the other three- those of Austria, Germany and the UK. In each case of partial rejections, the Commission indicated the steps that need to be taken by the Member State to make the plan fully acceptable[84].

If the Member States whose plans were partially rejected on July 7 implement the proposed changes they will not have to submit their plans to the Commission a second time, but automatically qualify for emissions trading.

The Commission identified problems in two areas of general importance:

- If the allocation chosen by a Member State for the 2005-2007 trading period jeopardizes the achievement of its Kyoto target (excessive allocation).
- If a Member States intends to make so- called "ex- post adjustments" to allocations. This means that the Member State plans to intervene in the market after the allocation is done, and redistribute the issued allowances among the participating companies during the 2005-2007 trading period.

Excessive allocation can result from various cases. Firstly, where a Member State does not reason how the Kyoto target in 2008-2012 would respect, but left a gap to be closed with measures to be defined later. Secondly, where a Member State states the intention to purchase Kyoto credits, but does not demonstrate credible and reliable steps to realize these purchases. Thirdly, where a Member State bases its plan on projections (including economic and emission growth rates) that are inconsistent and exaggerated compared to official growth forecasts by the Member State itself or other impartial sources.

[84] See http://europa.eu.int/rapid/pressReleasesActin.do?reference=MEMO/04/44&FORMAT=html

Ex- post adjustments are incompatible with the legal framework and represent interventions that disrupt the market and create uncertainty for companies. For example, if a company faces the possibility that the government may take away allowances after it has reduced its emissions, it will hesitate to do so. And if companies think they can receive additional allowances for free from their governments, they will pursue this route rather than turn to the market and buy allowances.

As of July 7, another ten plans had been submitted. The Commission would have concluded the assessments on these plans soon after the summer break. The decisions taken o the first eight plans have created a stable and predictable environment, as the Commission will apply the same approach and principles to the assessment of further plans.

Another seven plans were still missing on July 7. This is why the Commission decided on the same day to start infringement procedures against those two EU 15 countries that have failed to submit them in time: Greece and Italy. Those two countries have received first written warnings. The Commission decided to take legal action first against non- compliant EU 15 countries because their deadline for submitting the plans was 31 March 2004, while the deadline for the new Member States was 1 May.

It is in the interest of all Member States to submit a plan. Not preparing a national allocation plan means that the industry of that Member State would be denied access to the EU- wide allowance market, even though the targets under the Kyoto Protocol and the Burden-Sharing agreement need to be met.

Furthermore, companies covered by the Emissions Trading Scheme need to record and report their CO_2 emissions as of January 2005. They also need to deliver for the first time in April 2006 a sufficient number of allowances to cover emissions during 2005. If a company delivers no allowances- or not enough allowances- a sanction of €40 per non- delivered allowance will be imposed by the Member State.

5. NATIONAL ALLOCATION PLAN IN GREECE

A. THEORETICAL PERSPECTIVES

5. A.1. General Characteristics and Commitments

In the framework of the commitments that stem from Kyoto Protocol, European Community is bind to an emission reduction of 8% for the period 2008-2012. The distributive settlement at the interval of the European Community, constituted the objective in the Cabinet Council of Ministers of Environment in June 1998 (Burden- Sharing Agreement). Under the Kyoto Protocol, Greece is obliged to keep the increase of the emissions of greenhouse gases at 25% compared to the levels of 1990.

The Kyoto Protocol was ratified by Greece in 30 May, 2002. The Greek Parliament approved the National Program for mitigating greenhouse gases (2000-2010) by the law 3017/2002. In favor of the Protocol were placed the parties of ΠΑΣΟΚ, ΝΔ and ΣΥΝ, while against was placed the party of KKE.

According to the directions of the IPCC for the construction of the national census, emissions originated from the international overhead and marine transportations are not taken into account to the total national emissions.

The CO_2 emissions constitute the majority of the total emissions of greenhouse gases, since they were responsible for the 80.6% of the total emissions in Greece for the year 2000, while methane and nitrous oxide were responsible for the 7.9% and 8.2% in respect. Final, F-gases accounted for the rest 3.3%[85].

As far as it concerns each sector individually, activities concerning the energy sector are the main sources of greenhouse gases. In point of fact, it is registered[86]:

- Energy sector: emits 77.9% of greenhouse gases,
- Agriculture: 7.9%,
- Industry: 9.9%,
- Outcasts: 4.1%,
- Use of solvents: 0.1%.

The above can be seen in the figure 3.

[85] Carbon dioxide, methane and nitrous oxide have increased by 23% in relation to the base year, while the 6 greenhouse gases together have increased approximately 23, 4% in relation to the base year.

[86] See Government's Newspaper.

It is obvious that the energy sector contributes the most to the change of the atmosphere's collocation as far as it concerns Greece. Emissions from the energy sector are mainly consisting from CO_2 because of the combustion of fossil fuels (95% of the total emissions in energy sector) and smaller percentages of CH_4 and N_2O (1.5% and 3.5% in respect).

The level, structure and evolution of the domestic energy demand depend on the corresponding domestic economic activity, and the economy/ energy ratio. Although the average per capital income remains comparatively low, the Greek economy nevertheless underwent a period of intense development in the recent past, especially during the 1960s. Economic growth slackened in the 1970s, and was plunged into crisis during the 1980s, following the second energy crisis of 1979. Signs of a temporary recovery were observed during the 1986-89 period.

The total energy supply in Greece has been continuously increasing. Despite this general rapid increase, however, the average annual growth in the first five years of the 90s was reduced to approximately 1.4% per year, compared to 3.3% in the 80s. Although the energy system relies heavily on the use of petroleum products, their relative contribution to the energy system has fallen from 72.5% in 1980 to 60% in 1995, because of a gradual increase in the use of indigenous brown coal. The partial replacement of oil by lignite had a marked effect on the import dependency of energy, which dropped from 85.6% in 1980 to 78.1% in 1995. The sharp increase in the energy demand recorded throughout the 1970s and 1980s triggered an increase in the supply of electricity and an increased recourse to lignite, an energetically poor and, at the same time, highly polluting fossil fuel.

Although this specific policy helped to meet the needs of the times by restricting energy costs and reducing Greece's energy dependence, the environmental impact was nonetheless severe. Greece's per capital energy consumption still remains comparatively low. However, the required energy per unit product (primary demand or final consumption / GDP) is not only high, but has furthermore steadily increased throughout the 1970s and 1980s, contrary to the improvement noted in almost all of the countries of the Community and the OECD.

Thus the evolution of the Greek economy's energy intensity over the 1970-1990 periods brought about similar evolutions in the emissions of CO_2 (and other greenhouse gases).

5. A.2. Business- as- Usual

In order to examine and remark the different possibilities of intervention to the problem of mitigating the greenhouse gas emissions, a necessary presupposition is the formation of the Business- as- Usual Scenario.

The Business- as- Usual Scenario represents the future evolution of greenhouse gas emissions under the existing politics and behavior of the consumers. Thus in this Scenario, are taken into account the already itinerary politics in different sectors of economic action (transportation, industry, etc.) and are formed the estimations for the evolution of the emissions.

It is obvious that the Business- as- Usual Scenario is a crucial determining factor of the results, since the highest the emissions that are determined, the biggest is the effort of trying reducing them, in order to achieve the possible target that is set. Simultaneously, the high level of emissions of Business- as- Usual Scenario is helping to the localization of politics and measures for mitigating in a relevant low cost.

In any case, it must be noticed that the emissions that are evaluated in a Business- as- Usual Scenario are dependent on admissions related to basic measurements such as inflation, economic development, energy prices, etc. The time horizon that is chosen for the formation of the Business- as- Usual Scenario is the year 2020, so to be consistent with the first commitment period of the Kyoto Protocol (2008-2012) and moreover to have the possibility of forming a complete program of mitigating the greenhouse emissions with a midterm and long-term orientation.

For the evaluation of greenhouse emissions in the energy sector, the ENPEP (Energy and Power Evaluation Program) model was used. ENPEP was developed to the Argonne National Laboratory (ANL USA), is of hybrid type, and is consisted of different models with the target of the complete energy analysis of the energy system with a simultaneous quantification of the environmental and social consequences.

For the non- energy sectors, the evaluation of greenhouse gas emissions was not based on the use of an international calculating tool, but on the evolution of each activity for every source and the estimation of the appropriate coefficient. Practically, it is required the estimation of the average rate relatively to the base year.

5. A.2.1. Basic Admissions

As it is already mentioned, the valuation of the cost of mitigating the greenhouse gas emissions requires the formation of the Business- as- Usual Scenario, which estimates the evolution of the gases when no environmental applications are held. The level of estimated emissions is based on admissions which refer to basic parameters[87].

Demographic Characteristics: According to the results of the recent enrollment that the National Statistic Service held (2001), the population of Greece has increased for the period 1991-2001 with an average annual rate of 0,64%, while the average annual rate for the period 2001-2020 is estimated to 0.34%. The total number of households appears an increase of 37% for the period 1990-2020. The evolution of the population and households is a decisive parameter, since it designates in a high degree the energy consumption in domestic and tertiary sectors, as well as in transportations.

Weather Conditions: The admission that is adopted is that the weather will resemble the weather of the last years. The hypothesis that the climatologically conditions will be closer to the historical mean would ignore the remarkable rise of the average annual temperature in the last decade, and thus would lead to an inexcusable steep increase of the energy demand for countries' heating after 2000.

Macroeconomic extent: For the evaluation of GDP, the official short term evaluations (until the year 2002) of the Greek Government were used, while for the period up to the year 2020 the evaluations of the European Commission (1999) were used. The average annual rate for the period 2000-2005 is estimated to 4.3%, while for the period 2005-2010 falls to 3.4%. For the period after 2010, the annual economic enlargement of development is expected to stabilize at about 3%.

Prices/ fuels' taxation: The level of energy prices influences not only the future total energy demand of a particular energy system, but also the portions of different energy resources to the covering of this demand. Furthermore the different degree of penetration of alternative energy resources and technologies influence the level of greenhouse gases that come from the energy sector. The evolution of fuel prices presents crucial problems and uncertainties since it depends on international petroleum, natural gas and carbon markets, and the international pricing politic applications that are held. The majority of economic analysts agree that the international price of petroleum will not appear steep fluctuations for the following years.

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[87] See Government's Newspaper.

Politic applications and measurements: The Scenario of Expected Evolution presents the future development of the energy system under the existence politic measurements, consumers' behaviors and future trends. Specifically the Scenario of Expected Evolution contains:

- the liberation of the electricity market,
- the agreement between the EE and the cars industry for the emissions reduction of the new cars,
- the propelling of laws that refer to renewable resources of energy,

Discount Rate: The discount rate for the evaluation of alternative energy technologies will be differentiated according to the individual characteristics those who activate to the energy sectors. In specific terms, in domestic sector, consumers usually prefer investments with a small period of payment in full, and that's why a discount rate of 14% was adopted. On the other hand, industries, refineries, companies of common good, etc. draw their investment policy on a long- term basis, thus the discount rate of 6% was regarded as the most appropriate. Final, at the tertian sector a discount rate of 9% was adopted.

5.A.2.2. Results

The basic results that stem from the Business- as- Usual Scenario mainly concern the demand and supply of the primary energy and the production of electricity.

The domestic supply of first- born energy in Greece is expected to rise lightly during the period 2000-2020 with an average annual rate of 0.5%. The production of fossil fuels (lignite) grows during the period 1995-2020 about 15%, while the domestic production of fluid fuels has a drastic decrease through the decade 1995-2005, mainly due to the fact that the deposits of crude oil are expected to be used up. Furthermore the renewable energy sources are expected to be propelled due to their environmental characteristics and the political support from the Greek Government. Among the different renewable energy sources, the solar and αιολική energy are the ones which present a remarkable development.

The domestic demand for first- born energy in Greece is continually increasing[88] with an average annual rate of 2.1%. The fluid fuels cover the major part of the endogenous demand. However, their contribution falls from 59% in 1995 to 54% in 2010 and to 52% in 2020. The consumption of fossil fuels appears an increase of 15% during the period 1995-2020, while their contribution falls from 35% in 1995 to 24% in 2020. It is expected that the natural gas is going to cover a significant part of the demand, which is estimated to 15.1% in 2010 and to

[88] From 23.8 Mtoe in 1995 to 34 Mtoe in 2010 and 40 Mtoe in 2020.

20.1% in 2020, contributing in that way to the relevant decrease of the fossil and fluid fuels. The renewable energy sources will cover 4% of the total energy demand for the period 2000-2020.

As far as it concerns the production of electricity, it is reported an international long-term increase in the consumption of energy in the most sectors of developed countries. The same trend is expected in Greece for the following years. In particular, the demand of electricity is expected to rise with an average annual rate of 3.1% during the period 2000-2010, while this rate falls to 2.5% during the next decade. The imports of electricity will remain in low levels, thus the total needs in electricity must be produced from the Greek energy system. The introduction of natural gas and the liberation of the electricity market, represent significant articular evolutions that have been embodied in the Business- as- Usual Scenario.

The remarkable penetration of natural gas in the Greek electricity system, restrains the relevant contribution of the lignite units from 67% in 1995 to 47% in 2010 and 39% in 2020. However, in absolute numbers the electricity that is produced from lignite units is rising about 21% during the period 1995-2020. Totally, the use of natural gas for the production of electricity power corresponds to 28% of the produced electricity in 2010 and to 37% in 2020. On the other hand, the percentage of the produced electricity from petroleum units falls to 13% in 2010 and to 125 in 2020, while, the contribution of the renewable energy sources rises from 9.7% in 1995 to 11% in 2010 and to 11.6% in 2020.

The final consumption of energy in Greece is continually increasing during the whole period[89], with an average annual rate of 2.2%. The consumption of electric power presents an average annual rate of 3.4% for the years 1995-2010, while this rate falls to 2.5% during the last decade. The natural gas represents about the 7.1% of the final demand of energy in 2010, while this percentage increases to 8.5% in 2020.

The structure of the final consumption of energy in each sector, keeps pace with the characteristics of the economic development and the individual characteristics. The energy consumption in industry sector is expected to present a small decrease the next 25 years. Particular, the percentage for the decade 2000-2010 is expected to be about 27.7%, while the next decade this percentage falls to 25.7%. The consumption of transportation activity is anticipated to rise more than 2% during the period 1995-2020 like the tertiary sector which will present a significant increase in the order of 5%. The energy consumption in the agricultural sector is expected to reach 5.6- 6.3% during the period 1995- 2000 while the consumption of

[89] From 16.2 Mtoe in 1995 to 23.7 in 2010 and to 27.6 in 2020.

the domestic sector will decrease slightly mainly due to natural gas and the use of high performance apparatus.

5. A.3. Total Estimation of Greenhouse Gas Emissions

It has to be mentioned that the most accurate estimations concern the CO_2 emissions, which have been done according specific coefficients that are registered in IPCC, taking into account the Greek applications and the case of lignite. For the rest greenhouse gases (CH_4 and N_2O) the majority of the coefficients that were used, are proposed by the EMEP/ CORINAIR. The relevant estimations are characterized by significant uncertainty mainly because of the fact that the proposed coefficients in many cases don't respond to the Greek circumstances. Towards this direction, there is an effort of establishing emission coefficients that will reach the Greek conditions.

The Business- as- Usual Scenario leads to an increase of CO_2 emissions coming from the energy sector in the order of 44.9% in 2010 and about 65.6% in 2020 relevant to 1990 (see table 4). CO_2 emissions are expected to have an average annual rate of 2.3% during the 1990-2000 periods, while this rate falls to 1.5% for the 2000-2010 periods and to 1.3% for the last decade. The annual rate falls mainly due to the penetration of natural gas and the renewable energy sources.

Besides the energy sector, the transportation sector is regarded a significant source of CO_2 emissions as its share to the total emissions of CO_2 from energy sector is increasing from 20% in 1990 to 23.5% in 2010 and to 24.1% in 2020.

As far as it concerns CH_4 emissions, the sector of transportation and industry are responsible for the 43% and 28% respectively, of the total emissions in 2020. The total emissions of CH_4 are expected to decrease slightly after 2000 with an average annual rate in the order of 0.8%. On the other hand the electricity sector will be responsible for more than 50% of the total emissions during the 2000-2020 periods.

The total emissions of N_2O will increase with a rate reaching 1.3% for the next 20 years. In terms of equivalent tones of CO_2 the total greenhouse gases increase to 115.7 Mt in 2010 and to 132 Mt in 2020 compared to 79.9 Mt in 1990, with an average annual rate in the order of 1.7% (see table 5).

The evolution of greenhouse gases from industry activities depends on the level of activity in specific industry sectors. According to the Scenario of Expected Evolution the greenhouse gases in terms of equivalent tones of CO_2 present a continually increase until the year 2020 with an annual rate of 2.6%.

The N_2O emissions from agriculture for the 2000-2020 period decrease with a rate of 0.6% and the total decrease relevant to the base year 1990 is approximately 11% in 2010and 13% in2020. CH_4 emissions are slightly decreasing during the 2000-2020 period, with an average annual rate of 0.02%.

For the non- energy sectors, the evolution of greenhouse gas emissions has an increasing trend. In the industry sector the total level of greenhouse gases increases at 66% and 117% in 2010 and 2020 in respect, relevant to the base year. The use of solvents lead to an increase in emissions of CO_2 reaching 2.6% in 2020 while the average annual rate for the 2001- 2010 and 2010-2020 period concerning the outcasts is estimated to 35 and 2,3% in respect. Final the emissions coming from the agriculture sector tend to decrease by 7.5% in 2010 and 9.4% in 2020 in relation to the base year.

The total increase of greenhouse gases compared to the base year comes up to 35.8% for the year 2010 and 56.4% for the year 2020. The average annual rate of increase is estimated to 1.2% (see tables 6 and 7). The energy sector still remains the basic source of emissions with a contribution percentage of 76-79% during the whole period of meditation. The total results of the estimations of the greenhouse gases for the period 2000-2020 are shown in the following figure.

It has to be mentioned that the greenhouse gas emissions increase with a rate lower than the respectable sectoral economic development, mainly due to the energy performance of the system and the use of cleaner fuels.

Thus, there is an immediate need for the designing and materializing of a total program for the mitigation of the greenhouse gas emissions in Greece.

B. NATIONAL ALLOCATION PLAN IN PRACTICE

The following table shows us the total greenhouse gas emissions (in kt CO_2 eq) for Greece for the period 1990-1995.

GASES	1990	1991	1992	1993	1994	1995
CO_2	85586	84610	87672	87268	88627	87273
CH_4	8743	8705	9007	9106	9362	9494
N_2O	10622	10520	10468	10144	10258	9899
F-gases	1193	1364	1161	1791	2303	3452
Total	**106143**	**105199**	**108307**	**108308**	**110550**	**110119**
Base Year=100	97.9	97.0	99.9	99.9	102.0	101.6

According to the Kyoto Protocol Greece has the commitment to keep the greenhouse gas emissions in the order of 25% of the level of the base year 1990 and 1995 for the F- gases.

That means that the total emissions for the gases CO_2, CH_4 and N_2O in the base year were 85.586 + 8743 + 10622 = 104.951 kt CO_2 eq, while the total emissions for the F-gases in the base year were 3.452 kt CO_2 eq.

Since Greece has ratified the Kyoto Protocol, is obliged not to exceed these levels more than 25%. That means that should not exceed the limit of 131.188,75 kt CO2 eq for the CO_2, CH_4 and N_2O gases and the limit of 4.315 kt CO_2 eq for the F-gases. Thus the total burden of greenhouse gas emissions that Greece must not exceed comes to **135.503,75 kt CO2 eq** for the 2008-2012 period.

The following table shows the evolution of greenhouse gases in Greece in each sector (the evolution of greenhouse gases can be easily seen in figure 4).

	1990	1995	2000	2005	2010	2015	2020
ENERGY	80789	84386	101062	107787	116890	125205	133277
INDUSTRY	9591	11725	12874	13667	15899	18467	20787
SOLVENTS	177	156	169	173	177	179	181
AGRICULTURE	10448	9737	10227	9736	9668	9566	9467
FORESTS	1391	1307	4138	2030	2030	2030	2030
OUTCASTS	3749	4422	5319	4042	2542	2598	3793
sum	**106145**	**111733**	**133789**	**137435**	**147206**	**158045**	**169535**

Figure 5 shows the contribution of each sector to the total level of greenhouse gas emissions.

Thus, the percentages of greenhouse gases that each sector emits for the years 1990-2020 are the above:

	1990	1995	2000	2005	2010	2015	2020
ENERGY	76,1119	75,52468	75,5383	78,4276	79,4057	79,2211	78,6132
INDUSTRY	9,03575	10,49376	9,62261	9,94433	10,8005	11,6846	12,2611
SOLVENTS	0,16675	0,139618	0,12631	0,12587	0,12024	0,11325	0,10676
AGRICULTURE	9,84313	8,714524	7,64412	7,08407	6,56766	6,05270	5,58409
FORESTS	1,31047	1,169752	3,09293	1,47706	1,37902	1,28444	1,19739
OUTCASTS	3,53196	3,957649	3,97566	2,94102	1,72683	1,64383	2,23729
sum	**100**	**100**	**100**	**100**	**100**	**100**	**100**

The five- year changes for each sector will then be:

	1990	1995	2000	2005	2010	2015	2020
ENERGY	_	4,452	19,761	6,654	8,445	7,113	6,447
INDUSTRY	_	22,250	9,799	6,159	16,331	16,151	12,562
SOLVENTS	_	-11,864	8,333	2,366	2,312	1,129	1,117
AGRICULTURE	_	-6,805	5,032	-4,801	-0,698	-1,055	-1,034
FORESTS	_	-6,038	216,602	-50,942	0	0	0
OUTCASTS	_	17,951	20,284	-24,008	-37,110	2,202	45,996

The average annual rate of changing for each sector for the period 2000-2005 will then be:

Energy : 1.3308%, Industry : 1.2318%, Solvents : 0.4732%,

Agriculture : -0.9602%, Forests : -10.1884%, Outcasts : -4.8%.

Thus the evolution of greenhouse gases for the years 2000-2004 according the average annual rates for each sector will be the following:

	2000	2001	2002	2003	2004
ENERGY	101062	102406,9	103769,8	105150,7	106550,1
INDUSTRY	12874	13032,58	13193,12	13355,63	13520,14
SOLVENTS	169	169,7997	170,6032	171,4105	172,2216
AGRICULTURE	10227	10128,8	10031,54	9935,221	9839,823
FORESTS	4138	3716,404	3337,762	2997,697	2692,28
OUTCASTS	5319	5063,688	4820,631	4589,241	4368,957

sum	133789	134518,2	135323,4	136199,9	**137143,5**

It can be noticed that the total greenhouse gas emissions that sectors together will emit for the year 2004 are above the burden that Greece is allowed to emit for the years 2005-2012 (137.143,5 kt CO_2 eq > 135.503,75 kt CO_2 eq). Emissions for 2004 can also be seen in figure 6. It should be understood that the permit allocation for 2005 will depend on the emissions that each sector emits in 2004 (there is a diagrammatic representation of the commitment periods and targets in figure 7). Thus, there is a difference between the emissions that sectors should emit and the emissions that will finally emit. In that case, environmental measures and policies should be adopted from the Greek government in order to reach the burden and meet the target of the Kyoto Protocol.

The percentages of greenhouse gases that each sector emits in 2004 are the following:

Energy : 77.692%, Industry : 9.858%, Solvents : 0.125%,
Agriculture : 7.174%, Forests : 1.963%, Outcasts : 3.185%

Then the 135.503,75 kt CO_2 eq will be allocated to sectors according the above rations (see figures 8 and 9).

Energy : **105276,11 kt CO_2 eq or 77.69% of the total permits,**
Industry : **13358,491 kt CO_2 eq or 9.858% of the total permits,**
Solvents : **170.6244 kt CO_2 eq or 0.125% of the total permits,**
Agriculture : **9722,173 kt CO_2 eq or 7.174% of the total permits,**
Forests : **2660,0898 kt CO_2 eq or 1.963% of the total permits,**
Outcasts : **4316,7198 kt CO_2 eq or 3.185% of the total permits.**

SUMMARIZING

International Environmental Agreements have eventually become an important issue in global proscenium and possess a significant row in the Agenda of National Governments. The universal concern for the environment has forced nations to look up for quick answers and effective solutions to the ecological deterioration. Cooperation among states will be the cornerstone to all measures and policies that they will announce and try to bring into force. Unfortunately cooperation not only isn't always feasible but in many cases is inconceivable. Different types of distortions such as development asymmetries, free- riding incentives, economic heterogeneities, impede the realization of a coalition with common environmental goals.

The Kyoto Protocol, signed in December 1997 and hasn't come into force yet, is a prominent example of an environmental agreement which sets as an ultimate common pursuit the stabilization of greenhouse gases in the atmosphere in levels that won't harm climate. The Kyoto Protocol is characterized as rather ambitious and short term which fails to attain participation and compliance. Despite those facts, the Kyoto Protocol is the first which makes provisions for the climate regulation and the greenhouse effect.

Several different mechanisms, characterized as flexible, are proposed by the Protocol in order nations to achieve their commitment goals. Emission Trading System is the most popular and applicable mechanism and is going to start in 01/01/2005. The results are still unknown but is estimated that competitiveness among nations won't be harmed as long as the demand and supply mechanisms will work properly and unhindered.

Greece ratified the Protocol in 2002 but since then distinguished progress hasn't be made. Greece's National Allocation Plan is not submitted yet to the European Commission despite the warnings.

Based on estimations, Greece will not be consistent with its commitments and probably unbearable penalties will be imposed unless measures and policies are defined in the near future.

APPENDIX

Table 1. International Environmental Agreements[90]

PROTOCOL	OBJECTIVE	STATUS OF MEMBERSHIP
Antarctic Treaty	To ensure that Antarctica is used for peaceful purposes only; to defer the question of territorial claims asserted by some nations and not recognized by others; to provide an international forum for management of the region; applies to land and ice shelves south of 60 degrees South latitude.	Opened for signature in 1rst December 1959, entered into force in 23rd June 1961; presently counts 44 parties
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	To reduce transboundary movements of wastes subject to the Convention to a minimum consistent with the environmentally sound and efficient management of such wastes; to minimize the amount and toxicity of wastes generated and ensure their environmentally sound management as closely as possible to the source of generation.	Opened for signature in 22nd March 1989, entered into force in 5th May 1992; presently counts 143 parties.
Convention on Biological Diversity	To develop national strategies for the conservation and sustainable use of biological diversity	Opened for signature in 5th June 1992, entered into force 29th December 1993.
Framework Convention on Climate Change (FCCC)	Framework convention preceding the Kyoto Protocol; expresses concern about climate change due to greenhouse gases; no binding emission ceilings were set	Signed in Rio de Janeiro in 1992 by 166 countries; entered into force in 1994; presently counts 186 parties.
Kyoto Protocol	Targets at a reduction of greenhouse gas emissions based on 1990 emission levels to be achieved in the period 2008-2012.	Signed in Kyoto in 1997 by 38 countries; has not yet entered into force.
Vienna Convention	Expresses concern about the depletion of the ozone layer through CFCs and halons, no binding emission ceilings were set.	Signed in Vienna in 1985 by 28 countries, entered into force in 1988, currently counts 182 parties.
Montreal Protocol	CFCs have to be cut to half of 1986 levels by 1999; starting with a freeze of production and consumption within one year after the Protocol will be in force.	Signed in Montreal in 1987 by 46 countries; entered into force in 1989, currently counts 181 parties.
Convention on Long- Range Transboundary Pollution (LRTAP)	Expresses concern about transboundary pollution problems (e.g. acidification of lakes and soils)	Signed in Geneva in 1979 by 33 countries; entered into force in 1983, currently counts 48 parties.
Helsinki Protocol	Targets at 30 percent reduction of sulfur emissions based on 1980 levels by 1993	Signed in Helsinki in 1985 by 19 countries; entered into force in 1987; currently counts 22 parties.
Sofia Protocol	Targets at uniform freeze of nitrogen oxides at 1987 levels by 1995	Signed in Sofia in 1988 by 25 countries; entered into force in 1991; currently counts 28 parties.
Geneva Protocol	Targets at 30 percent reduction of volatile organic compounds based on 1998 levels by 1999	Signed in Geneva in 1991 by 23 countries; entered into force in 1997; currently counts 21

90 See Finus M. (2004), pg 27-28 and Xepapadeas A.(2003), pg 10-23.

		parties.
Oslo Protocol	Follow- up Protocol of the Helsinki Protocol; sets tighter non- uniform emission ceilings to be achieved by 2000 so that critical loads are not exceeded.	Signed in Oslo in 1994 by 28 countries; entered into force in 1998; currently counts 24 parties.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Banning of commercial international trade with endangered species.	Signed in Washington in 1973 by 43 countries; entered into force in 1975; currently counts 152 parties.
The International Convention for the Regulation of Whaling (ICRW)	Establishment of a system of international regulations to ensure the conservation and development of whale stocks.	Signed in Washington in 1946 by 15 countries; entered into force in 1948; currently counts 48 parties.
The Waigani Convention	Regional convention in the South Pacific region to ban the importation of hazardous and radioactive wastes and to control the movement of these substances.	Signed in Waigani, Papua New Guinea, in 1995 by 14 countries; entered into force in 2001; currently counts 8 parties.
The Columbia River Treaty	Coordination of flood control and electrical energy production in the Columbia river Basin between the United States and Canada.	Signed in 1961 by the USA and Canada; further negotiations resulted in a Protocol signed and ratified in 1964.

Signature means the formal acceptance of the treaty targets by the negotiators of a treaty. Ratification is the formal confirmation and approval of a treaty that is necessary for a treaty to become binding. Accession means that a state is not among the original negotiators (signatories) and enters a treaty at a later stage. Accession implies de facto signature and ratification at the same time. Entry into force means that treaty provisions become binding, which requires usually a certain number of ratifications and/ or accessions. Signatories comprise countries that signed a treaty and parties comprise countries which deposited their formal confirmation and approval of a treaty through ratification or accession.

Table 2. List of Annex I Parties to the Convention

List of countries in alphabetical order

(http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php)

o Australia	Austria	Belarus
o Belgium	Bulgaria	Canada
o Czech Republic	Denmark	Estonia
o European Community	Finland	France
o Germany	Greece	Hungary
o Iceland	Ireland	Italy
o Japan	Latvia	Lithuania

o Luxembourg	Netherlands	New Zealand
o Norway	Poland	Portugal
o Romania	Russian Federation	Slovak Republic
o Spain	Sweden	Switzerland
o Turkey	United Kingdom Of G. Britain and Northern Ireland	United States of America

<u>Table 3.</u> List of Non- Annex I Parties to the Convention

List of countries in alphabetical order

(http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php)

o Afghanistan	Albania	Algeria
o Andorra	Angola	Antigua & Barbuda
o Argentina	Armenia	Azerbaijan
o Bahamas	Bahrain	Bangladesh
o Barbados	Belize	Benin
o Bhutan	Bolivia	Bosnia & Herzegovina
o Botswana	Brazil	Brunei Darussalam
o Burkina Faso	Burundi	Cambodia
o Cameroon	Cape Verde	Centr. African Republic
o Chad	Chile	China
o Colombia	Comoros	Congo
o Cook Islands	Costa Rica	Cote d' Ivoire
o Croatia	Cuba	Cyprus
o Democratic People's Republic of Korea	Democratic Republic of the Congo	Djibouti
o Dominica	Dominican Republic	Ecuador
o Egypt	El Salvador	Equatorial Guinea
o Eritrea	Ethiopia	Fiji
o Gabon	Gambia	Georgia
o Ghana	Grenada	Guatemala
o Guinea	Guinea Bissau	Guyana
o Haiti	Holy See	Honduras
o India	Indonesia	Iran

o Iraq	Israel	Jamaica
o Jordan	Kazakhstan	Kenya
o Kiribati	Kuwait	Kyrgyzstan
o Lao People's Democratic Republic	Lebanon	Lesotho
o Liberia	Libyen Arab Jamahiriya	Liechtenstein
o Former Yugoslav Republic	Madagascar	Malawi
o Malaysia	Maldives	Mali
o Malta	Marshall Islands	Mauritania
o Mauritius	Mexico	Micronesia
o Monaco	Mongolia	Morocco
o Mozambique	Myanmar	Namibia
o Nauru	Nepal	Nicaragua
o Niger	Nigeria	Niue
o Oman	Pakistan	Palau
o Panama	Papua N. Guinea	Paraguay
o Peru	Philippines	Qatar
o Republic of Korea	Republic of Moldova	Rwanda
o Saint Kitts and Nevis	Saint Lucia	S. Vincent and the Grenadines
o Samoa	San Marino	Sao Tome and Principe
o Saudi Arabia	Senegal	Serbia and Montenegro
o Seychelles	Sierra Leone	Singapore
o Slovenia	Solomon Islands	Somalia
o South Africa	Sri Lanka	Sudan
o Suriname	Swaziland	Syrian Arab Republic
o Tajikistan	Thailand	Togo
o Tonga	Trinidad and Tobago	Tunisia
o Turkmenistan	Tuvalu	Uganda
o Ukraine	United Arab Emirates	United Republic of

		Tanzania
o Uruguay	Uzbekistan	Vanuatu
o Venezuela	Viet Nam	Yemen
o Zambia	Zimbabwe	

Table 4. **Evolution of greenhouse gases from the energy sector in Greece (kt)**

SECTOR	POL.	1990	1995	2000	2005	2010	2015	2020
TOTAL	**CO_2**	**76474**	**79778**	**95682**	**102083**	**110838**	**118866**	**126647**
	CH_4	**15.0**	**16.3**	**21.8**	**19.2**	**18.8**	**18.7**	**19.1**
	N_2O	**9.9**	**10.4**	**12.1**	**13.4**	**14.3**	**15.1**	**15.8**
ENERGY PRODUCTION	**CO_2**	41202	42746	51702	53199	58141	62877	67564
	CH_4	0.3	0.31	0.4	0.9	0.9	0.9	1.0
	N_2O	5.5	5.9	6.6	6.9	7.5	8.0	8.5
INDUSTRY	**CO_2**	11892	11913	13771	14063	14537	14837	15189
	CH_4	1.6	2.5	3.7	4.3	4.5	4.8	5.3
	N_2O	1.8	1.8	2.0	2.4	2.4	2.4	2.5
TRANSPORTATION	**CO_2**	15358	16970	19182	23324	26070	28409	30514
	CH_4	5.1	6.3	7.4	7.6	8.0	8.1	8.2
	N_2O	0.6	0.9	1.2	2.0	2.3	2.4	2.6
AGRICULTURAL	**CO_2**	2815	2639	2659	2758	2871	3004	3149
	CH_4	0.4	0.4	0.4	0.2	0.2	0.3	0.3
	N_2O	1.1	1.0	1.0	1.0	1.0	1.1	1.2
DOMESTIC	**CO_2**	4684	4851	7592	7840	8103	8394	8631
	CH_4	7.0	6.72	9.8	6.2	5.1	4.6	4.3
	N_2O	0.8	0.8	1.3	1.1	1.0	1.0	1.0
TERTIARY	**CO_2**	523	659	776	899	1115	1345	1600
	CH_4	0.7	0.0	0.0	0.0	0.1	0.1	0.1
	N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 5. **Evolution of greenhouse gases from the energy sector in Greece (kt CO_2 eq)**

SECTOR	POL.	1990	1995	2000	2005	2010	2015	2020
TOTAL	**CO_2 eq**	**79859**	**83354**	**99890**	**106636**	**115677**	**123930**	**131951**
	CO_2	**76474**	**79778**	**95682**	**102083**	**110838**	**118866**	**126647**
	CH_4	**316**	**342**	**457**	**403**	**395**	**393**	**400**

	N_2O	**3069**	**3233**	**3751**	**4150**	**4445**	**4671**	**4904**
ENERGY PRODUCTION	CO_2 eq	42910	44569	53746	55360	60489	65377	70214
	CO_2	41202	42746	51702	53199	58141	62877	67564
	CH_4	6	7	8	18	19	20	20
	N_2O	1702	1817	2037	2143	2330	2481	2630
INDUSTRY	CO_2 eq	12486	12518	14460	14889	15382	15696	16076
	CO_2	11892	11913	13771	14063	14537	14837	15189
	CH_4	33	53	78	90	95	100	111
	N_2O	561	552	611	735	749	759	776
TRANSPORTA TION	CO_2 eq	15660	17394	19719	24091	26940	29334	31480
	CO_2	15358	16970	19182	23324	26070	28409	30514
	CH_4	107	132	155	159	167	170	171
	N_2O	195	291	381	608	702	754	794
AGRICULTUR AL	CO_2 eq	3148	2948	2972	3068	3199	3350	3514
	CO_2	2815	2639	2659	2758	2871	3004	3149
	CH_4	8	9	9	5	5	5	6
	N_2O	326	301	304	305	322	341	360
DOMESTIC	CO_2 eq	5085	5240	8186	8301	8520	8791	9027
	CO_2	4684	4851	7592	7840	8103	8394	8631
	CH_4	147	141	206	130	107	96	91
	N_2O	254	248	388	330	310	301	304
TERTIARY	CO_2 eq	569	688	807	928	1147	1381	1640
	CO_2	523	659	776	899	1115	1345	1600
	CH_4	15	0	0	1	1	1	1
	N_2O	31	28	31	28	31	35	39

Table 6. Total evolution of greenhouse gases in Greece

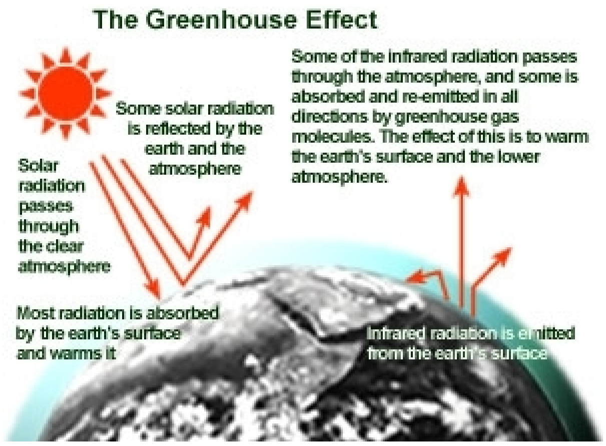
	1990	1995	2000	2005	2010	2015	2020
CO_2 Emissions (kt)	**85586**	**87273**	**107817**	**111962**	**120816**	**128947**	**136834**
Energy	76474	79778	95682	102083	110838	118866	126647
Industry	7686	7709	7877	7929	8026	8126	8230
Solvents	177	156	169	173	177	179	181
Agriculture							
Forests	1249	1370	4090	1776	1776	1776	1776
Outcasts							
CH_4 Emissions (kt)	**416.3**	**452.1**	**503.0**	**447.4**	**377.9**	**382.8**	**442.0**
Energy	59.3	65.4	77.6	74.0	76.6	79.4	82.2
Industry							
Solvents							
Agriculture	172.7	173.6	170.1	171.0	170.4	169.8	169.3
Forests	5.7	2.4	2.0	9.9	9.9	9.9	9.9
Outcasts	178.5	210.6	253.3	192.5	121.1	123.7	180.6
N_2O Emissions (kt)	**34.3**	**31.9**	**35.4**	**35.2**	**36.0**	**36.4**	**36.9**

Energy	9.9	10.4	12.1	13.4	14.3	15.1	15.8
Industry	2.3	1.8	1.8	1.8	1.8	1.8	1.8
Solvents							
Agriculture	22.0	19.6	21.5	19.8	19.6	19.4	19.1
Forests	0.1	0.0	0.0	0.2	0.2	0.2	0.2
Outcasts							
F-gases Emissions (kt)	**1193**	**3452**	**4429**	**5171**	**7306**	**9774**	**11990**
Energy							
Industry	1193	3452	4429	5171	7306	9774	11990
Solvents							
Agriculture							
Forests							
Outcasts							

Table 7. Total evolution of greenhouse gases in Greece (kt CO_2 eq)

	1990	1995	2000	2005	2010	2015	2020
Energy	80789	84386	101062	107787	116890	125205	133277
Industry	9591	11725	12874	13667	15899	1467	20787
Solvents	177	156	169	173	177	179	181
Agriculture	10448	9737	10227	9736	9668	9566	9467
Forests	1391	1307	4138	2030	2030	2030	2030
Outcasts	3749	4422	5319	4042	2542	2598	3793
TOTAL	**106145**	**110120**	**133789**	**137435**	**147206**	**158046**	**169536**

Figure 1. The greenhouse effect

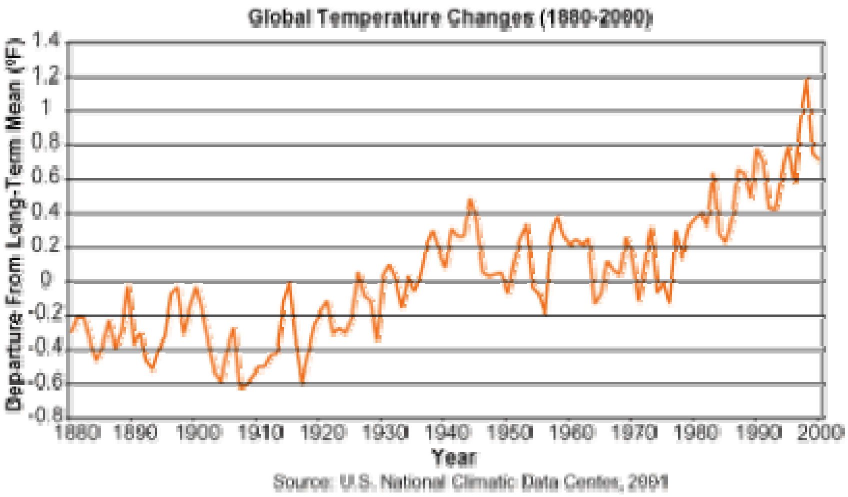


Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural "greenhouse effect", temperatures would be much lower than they are now, and life as known today would not be possible. The natural greenhouse effect raises the temperature of the planet by 33°C, thus making it habitable. However, problems may arise when the atmospheric concentration of greenhouse gases increases.

Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. The combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide.

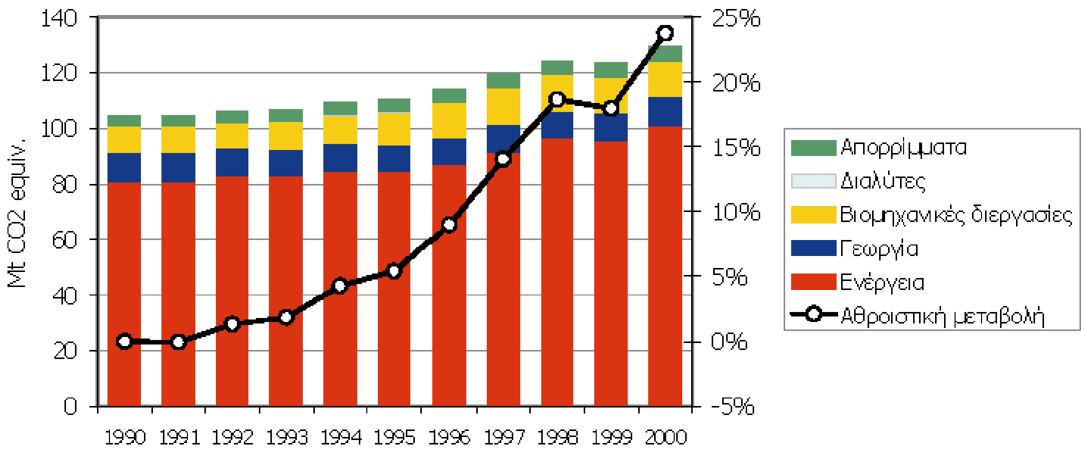
(http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html)

Figure 2. **Global temperature changes**

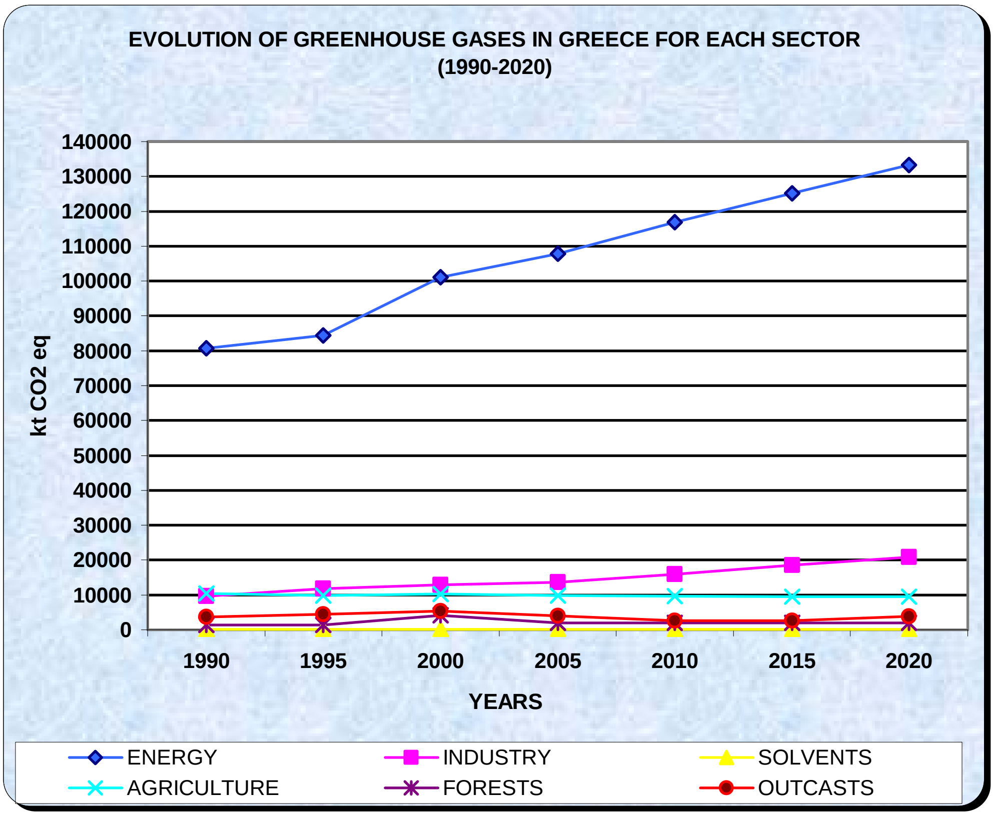


Global mean surface temperatures have increased 0.5- 1.0°F since the late 19th century. The 20th century's 10 warmest years all occurred in the last 15 years of the century. Of these, 1998 was the warmest year on record. Increasing concentrations of greenhouse gases will accelerate the rate of climate change.

Figure 3. **Total Greenhouse gases (in kt CO_2 eq) in each sector**



<u>Figure 4.</u> The evolution of greenhouse gases for each sector



<u>Figure 5</u>. Each sector's share to the total level of greenhouse gases

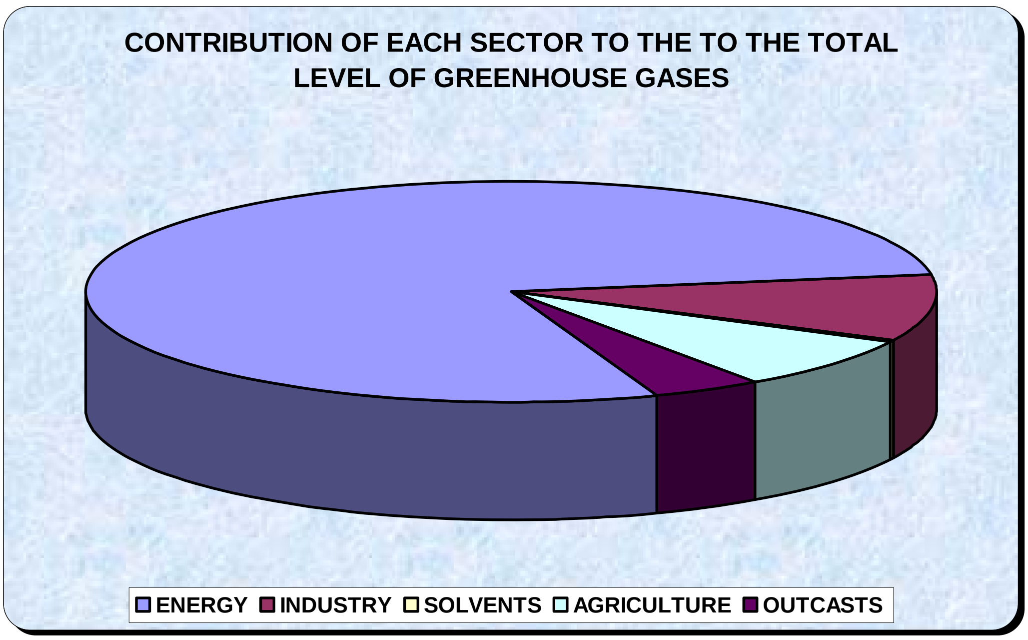


Figure 6. **Emissions in 2004**

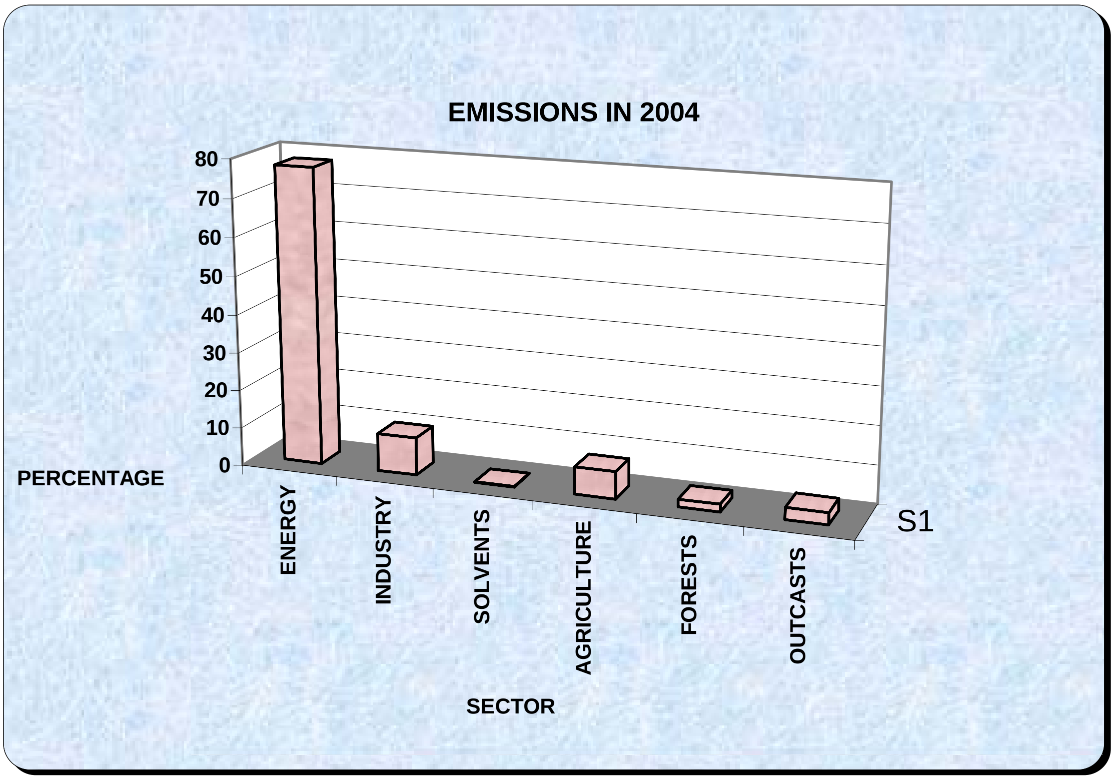
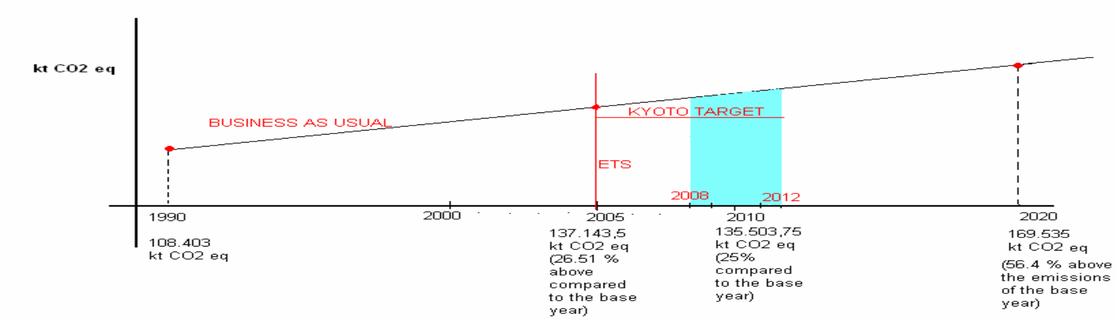
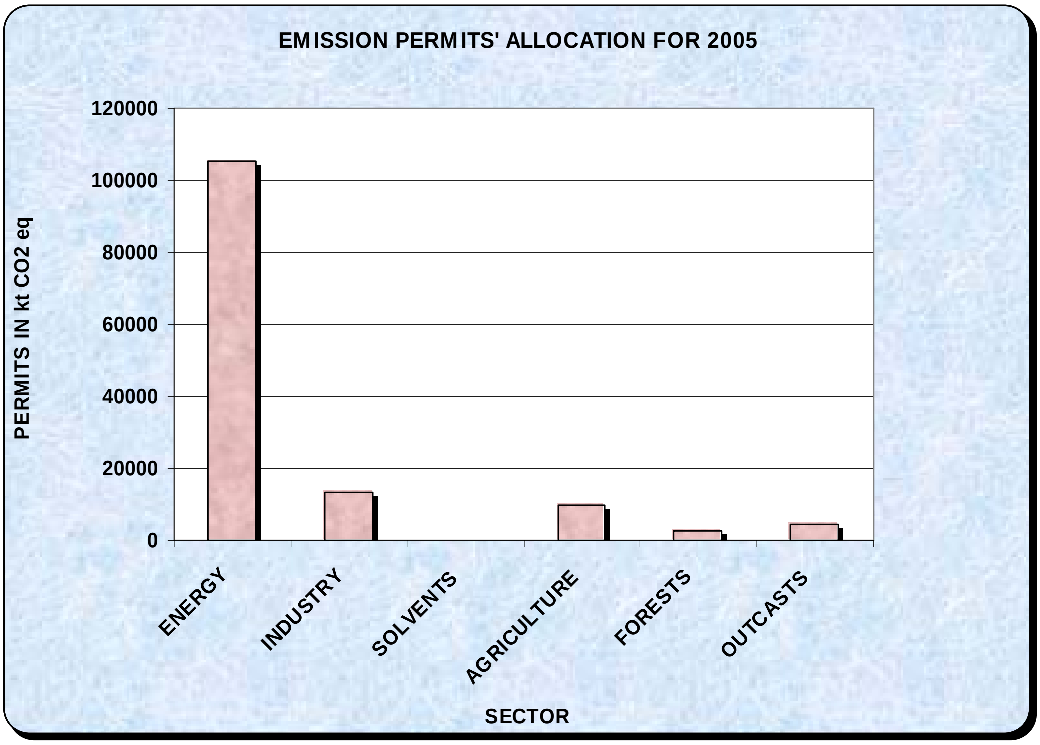


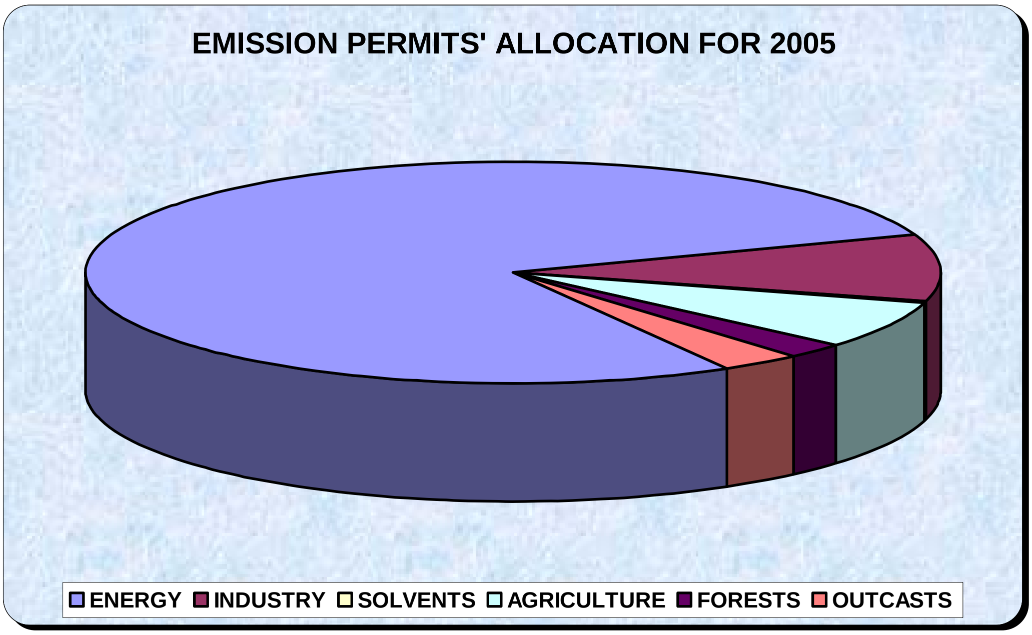
Figure 9.



<u>Figure 8.</u> Emission permit's allocation for 2005



<u>Figure 9.</u> Emission permit's allocation for 2005



REFERENCES

ENGLISH

1. Aldy,J. E., Barrett S. and Stavins R. N., (2003), "Thirteen Plus One: A Comparison of Global Climate Policy Architectures", Fondazione ENI Enrico Mattei Discussion Paper 64.2003, Milan
2. Ayres Robert U. and Walter Jorg (1991), "The Greenhouse Effect: Damages, Costs and Abatement", *Environmental and Resourse Economics,* **1** (3), pg 239-270.
3. Barrett Scott (1998), "A Theory of International Co- operation", Fondazione ENI Enrico Mattei Discussion Paper 43.98, Milan.
4. Barrett Scott and Stavins Robert (2002), "Increasing Participation and Compliance in International Climate Change Agreements", Fondazione ENI Enrico Mattei Discussion Paper 94.2002, Milan.
5. Bertram Geoffrey (1992), "Tradable Emission Permitss and the Control of Greenhouse Gases", in Tietenberg Tom (ed.), *The International Library of Critical Writings in Economics: The Economics of Global Warming,* Edward Elgar, 423-446.
6. Boemare Catherine and Quirion Philippe (2002), "Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences", Fondazione ENI Enrico Mattei Discussion Paper 35.2002, Milan.
7. Bohringer Christoph and Loschel Andreas (2003), "Post- Kyoto Climate Policy: A Computable General Equilibrium Analysis based on an Expert Poll", Centre for the European Economic Research (ZEW).
8. Buchner Barbara K. and Roson Roberto (2002), "Conflicting Perspectives in Trade and Environmental Negotiations", Fondazione ENI Enrico Mattei Discussion Paper 68.2002, Milan.
9. Buchner Barbara K. and Schleicher Stefan P. (2002), "Evaluating the Impact of Externalities and Cooperation on the Efficiency of the Kyoto Mechanisms".
10. Buchner Barbara K. and Carraro Carlo (2003), 'Emissions Trading Regimes and Incentives to Participate in International Climate Agreements", Fondazione ENI Enrico Mattei Discussion Paper 104.2003, Milan.

11. Buchner Barbara K. and Carraro Carlo (2004), "Economic and Environmental Effectiveness of a Technology- based Climate Protocol", Fondazione ENI Enrico Mattei Discussion Paper 61.2004, Milan.
12. Capparos Alejandro, Hammoudi Abdelhakim and Tazdait Tarik (2004), "On Coalition Formation with Heterogeneous Agents", Fondazione ENI Enrico Mattei Discussion Paper 70.2004, Milan.
13. Carraro Carlo (1993) "Strategies for the International Protection of the Environment", *Journal of Public Economics,* **52**, 309-328.
14. Carraro Carlo (1998), "The Structure of International Environmental Agreements", Fondazione ENI Enrico Mattei Discussion Paper 12.98, Milan.
15. Carraro Carlo (2000), "Costs, Structure and Equity of International Regimes for Climate Change Mitigation", Fondazione ENI Enrico Mattei Discussion Paper 61.2000, Milan.
16. Carraro Carlo and Marchiori Carmen (2003), "Endogenous Strategic Issue Linkage in International Negotiations", Fondazione ENI Enrico Mattei Discussion Paper 40.2003, Milan.
17. Carraro Carlo, Marchiori Carmen and Oreffice Sonia (2003), "Endogenous Minimum Participation in International Environmental Treaties", Fondazione ENI Enrico Mattei Discussion Paper 113.2003, Milan.
18. Carraro Carlo and Siniscalco Domenico (1991), "The International Protection of the Environment. Voluntary Agreements among Sovereign Countries", Fondazione ENI Enrico Mattei Discussion Paper 1.91, Milan.
19. Carraro Carlo and Siniscalco Domenico (1993), "Strategies for the International Protection of the Environment", *Journal of Public Economics,***52**, pg 309-328.
20. Convery Frank J., Redmond Luke, Dunne Louise, Ryan Lisa B., "Assessing the European Union Emissions Trading Directive", Mimeo, UC Dublin.
21. Diamantoudi Effrosyni and Sartzetakis Eftichios (2002), "Stable International Environmental Agreements: An Analytical Approach", Fondazione ENI Enrico Mattei Discussion Paper 7.2002, Milan.
22. Dockner Engelbert J. and Ngo Van Long (1993), "International Pollution Control: Cooperative versus Noncooperative Strategies", *Journal of Environmental Economics and Management,* **24**, 13-29.
23. Eyckmans Johan and Finus Michael (2003), "New Roads to International Environmental Agreements: The case of Global Warming", Fondazione ENI Enrico Mattei Discussion Paper 88.2003, Milan.

24. Finus Michael (2000), "Game Theory and International Environmental Co- operation: A Survey with an Application to the Kyoto- Protocol", Fondazione ENI Enrico Mattei Discussion Paper 86.2000, Milan.
25. Finus Michael (2004), "International Cooperation to Resolve International Pollution Problems", Fondazione ENI Enrico Mattei Discussion Paper 41.2004, Milan.
26. Finus Michael and Rundshagen Bianca (2003), "How the Rules of Coalition Formation Affect Stability of International Environmental Agreements", Fondazione ENI Enrico Mattei Discussion Paper 62.2003, Milan.
27. Finus Michael, Ekko van Ierland and Rob Dellink (2003), "Stability of Climate Coalitions in a Cartel Formation Game", Fondazione ENI Enrico Mattei Discussion Paper 61.2003, Milan.
28. Folmer Henk, Mouche Pierre and Ragland Shannon (1993), "Interconnected Games and International Environmental Problems", *Environmental and Resource Economics,* **3**, (4), 313-335.
29. Grubb Michael (2000), "The Kyoto Protocol: an Economic Appraisal", Fondazione ENI Enrico Mattei Discussion Paper 30.2000, Milan.
30. Harrison David and Radov Daniel B., (2002), "Evaluation of Alternative Initial Allocation Mechanisms in a European Union Greenhouse Gas Emissions Allowance Trading Scheme", *National Economic Research Associates,* prepared for DG Environment, European Commission.
31. Hoel Michael (1992), "International Environmental Conventions: The Case of Uniform Reductions of Emissions", *Environmental and Resource Economics,* **2**, (2), 141-159.
32. Hourcade Jean Charles and Baron Richard (1993), "Tradeable Permits", in OECD (1993), *International Economic Instruments and Climate Change,* Paris.
33. Kelly Mary, "Developing Ireland's National Allocation Plan", *Environmental Protection Agency,* Mimeo, UC Dublin.
34. Klepper Gernot and Peterson Sonja (2004), "The EU Emissions Trading Scheme Allowance Prices, Trade Flows, Competitiveness Effects", Fondazione ENI Enrico Mattei Discussion Paper 49.2004, Milan.
35. Markandya Anil and Rubbelke Dirk T.G. (2003), "Ancillary Benefits of Climate Policy", Fondazione ENI Enrico Mattei Discussion Paper 105.2003, Milan.
36. Rehdanz Katrin and Tol Richard S. J. (2002), "On National and International Trade in Greenhouse Gas Emission Permits", Fondazione ENI Enrico Mattei Discussion Paper 37.2002, Milan.

37. Sartzetakis Eftichios S., (1997), "Tradeable Emission Permits Regulations in the Presence of Imperfectly Competitive Product Markets: Welfare Implications", *Environmental and Resource Economics,* **9**, pg 65-81.
38. Stavins Robert N., (1995), "Transaction Costs and Tradable Permits", *Journal of Environmental Economics and Management,* **29**, pg 133-148.
39. Tietenberg Tom (2002), "The Tradable Permits Approach to Protecting the Commons: What Have we learned?" Fondazione ENI Enrico Mattei Discussion Paper 36.2002, Milan.
40. UNFCC (2004), "Information on national greenhouse gas inventory data from Parties included in Annex I to the Convention for the period 1990-2002, including the status of reporting. Executive summary".
41. Xepapadeas, A. (1995), "Managing the International Commons: Resource Use and Pollution Control", *Environmental and Resource Economics,* **5**, (4), pg 375- 391.
42. Xepapadeas, A. (1997), *Advanced Principles in Environmental Policy,* Edward Elgar.
43. Xepapadeas, A. (2000), "International Dimensions of Environmental Policy", *Environment and Development Economics,* **5,** pg 519-525.
44. Zapfel Peter and Vainio Matti (2002), "Pathways to European Greenhouse Gas Emissions Trading History and Misconceptions", Fondazione ENI Enrico Mattei Discussion Paper 85.2002, Milan.

GREEK

1. Εφημερίς της Κυβερνήσεως της Ελληνικής Δημοκρατίας, Αρ. φύλλου 58, 5 Μαρτίου 2003.
2. Σαρτζετάκης Ευτύχιος (2003), «Εφαρμογή Μεταβιβάσιμων Αδειών Εκπομπών στην Ευρωπαϊκή Ένωση», Mimeo, Πανεπιστήμιο Μακεδονίας.

LINKS

- http://physics4u.gr/news/2001/scnews262.html
- http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html
- http://unfccc.int/resource/docs/convkp/kpeng.html
- http://unfccc.int/kyoto_mechanisms/ji/items/1674.php

- http://unfccc.int/kyoto_mechanisms/cdm/items/2718.php
- http://unfccc.int/kyoto_mechanisms/compliance/items/3024.php
- http://www.eia.doe.gov/oiaf/kyoto/scope.html
- http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php
- http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php
- http://unfccc.int/resource/docs/convkp/kpeng.html
- http://www.eia.doe.gov/neic/press/press109.html
- http://www.nmsi.ac.uk/creativeplanet/pdfs/creativeplanet.pdf
- file://D:/CO_2_Permits\Energy_Use%20and%20CO2.html
- http://europa.eu.int/rapid/pressReleasesActin.do?reference=MEMO/04/44&FORMAT=html