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MARKET BASED MECHANISMS FOR ACHIEVING KYOTO TARGETS: THE CASE STUDY OF GREECE

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CONTENTS

LIST OF ABBREVIATIONS

AAU Assigned amount unit (exchanged through emissions trading)

CDM Clean development mechanism

CER Certified emission reduction (generated through the CDM)

COP Conference of the Parties

EIT Economy in transition (countries of the former Soviet Union and Central and Eastern Europe)

ERU Emission reduction unit (generated though joint implementation projects)

ETS Emissions Trading scheme

IEA International Energy Agency

INC Intergovernmental Negotiating Committee for the UNFCCC (1990-95)

IPCC Intergovernmental Panel on Climate Change

LULUCF Land use, land-use change and forestry

NAP National Allocation Plan

NGO Non-governmental organization

OECD Organisation for Economic Co-operation and Development

OPEC Organization of Petroleum Exporting Countries

UNEP United Nations Environment Programme

UNFCCC United Nations Framework Convention on Climate Change

WMO World Meteorological Organization

Abstract

In recent years, the existence of Global Warming concerns whole earth and requires the adoption of policies in order to prevent its negative impacts. Addressing the global issue of climate change, the United Nations Framework Convention on Climate Change (UNFCCC) through its Kyoto Protocol has taken a pragmatic approach: total emissions must be reduced. One of the mechanisms that Protocol authorizes in order to improve the cost effectiveness of the emissions reductions measures is the emission trading. The European Union decided to reallocate its target (-8% from the level of 1990) among its members taking advantage of a scheme under the protocol know as “bubble”. Under the EU Emission Trading Scheme each Member State of the European Union must develop and submit to European Commission a National Allocation Plan (NAP) of allowances for the three-year period 2005-2007.

This dissertation has three main objectives. Firstly, it aims to analyze the National Allocation Plan of Greece. Secondly, it checks the attitude of Greek companies towards market based mechanisms to combat global warming by the distribution of a questionnaire on the subject. Finally, it presents future scenarios about the position of Greece in EU Carbon Market.

1.Introduction

The tendency of the Earth's surface to increase, popularly termed the "global warming", led nations to take action. Nowadays it is accepted that human activities contribute to global warming by increasing greenhouse gases concentrations and adding new one (chlorofluorocarbons- CFCs). In order to avoid a continued rapid growth at GHGs in the atmosphere, severe reductions on emissions will be necessary. So, the United Nations Framework Convention on Climate Change (UNFCCC) through its Kyoto protocol has established mechanisms to reduce emissions and promote sustainable development.

Specifically, the Kyoto Protocol authorizes three market flexibility mechanisms to reduce GHG emissions: Joint Implementation (JI), Clean Development Mechanism (CDM) and Emissions Trading. The first two mechanisms give the opportunity to investing parties to receive more rights to pollute by implementing projects that reduce emissions in other countries. Emissions trading is a market-based mechanism by which pollution sectors can reach Kyoto targets less costly. In particular sources with high marginal abatement costs will choose to purchase credits from firms with lower abatement costs. Thus, the participators in the emissions market according to their cost effectiveness decide to buy or sell permits

The tradable permits approach in order to reduce emissions was first conceived by the Canadian economist John Dales in 1968. In 1977 the USA was first operated an emission trading Scheme through the Clean Air Act, a federal law by which the Environmental Protection Agency (EPA) sets a limit on the maximum allowable concentrations of a pollutant in the air anywhere in the country. The EPA's emission trading program achieved cost efficiency while generally having neutral impact on both the level of emissions and on air quality. Since then, many countries have followed its paradigm and have implemented some forms of emission trading market. However, the most ambitious and environmental effective scheme is the one which Kyoto protocol proposed as it involves many nations. Consequently, the EU Emissions Trading Scheme is a fundamental indicator of Kyoto's protocol effectiveness.

The EU ETS is a cap-and-trade allowance trading system as it establishes an aggregate emission cap on total emissions from a group of sources and creates financial incentive to reduce emissions. The "global warming" is a situation where is needed environmental certainty and cap-and-trade programs are preferable as the cap set an emission goal that sources must meet.

Experience with market-based approaches to protect environmental resources has demonstrated that properly designed programs can combine environmental improvement with cost effectiveness compared to other regulative approaches. However, there are market imperfections in the European Economies that can reduce the efficiency of trading.

In this dissertation we focus on the Greek position in the EU ETS. Specifically, the purposes of this thesis are 1. to analyze the Greek National Allocation of Emission Allowances, 2. to determine the opinion that major Greek companies hold about the carbon market by the distribution of a questionnaire on the subject, 3. to evaluate future scenarios in carbon market and estimate the environmental cost that emissions trading implies for inland market.

2. Economic instruments in theory

2.1. Efficiency and Market Failure

In economic theory pollution is considered as an externality whose occurrence brings out an inefficient or sub-optimal allocation of limited resources. Thus, remedial devices are necessary to launch an optimal solution that maximizes the social welfare. An externality is present whenever

- The utility of one consumer is **directly affected** by the actions of another consumer. For example, other agents, consumption of tobacco, alcohol and so on may affect some consumers. Consumer might also be adversely affected by firms who produce pollution or noise. This kind of externality is called consumption externality.
- The production set of one firm is **directly affected** by the actions of another agent. For example, the production of smoke by a steel mill may directly affect the production of clean clothes by a laundry. This kind of externality is called production externality.

It must be noted that externalities can be both, negative and positive. Our analysis is concentrated on negative externalities as they are unbreakably connected to environmental degradation.

Special cases of externalities arise when a natural resource (such as air) is a common property resource. In cases where a natural resource is open access it can be used by any agent without restriction or consideration of any negative external impact imposed on other agents. Consequently, open access resources, which no private person owns, tend to be used irrational as they have common characteristics with public goods. Bator, in his "Anatomy of Market Failure" points out that many externalities partake of the character of public goods. If the air in a city is polluted, it deteriorates simultaneously for every resident of the area and not just for any one individual. Air pollution then, is clearly a public "bad". Generally, environmental economics characterize pollution as a public "bad", resulting from waste discharged in the production of private goods.

In the presence of externalities some assumptions of welfare theorems[1] do not hold and the market failures leading to sub-optimal allocation of resources. An allocation of resources is pareto sub-optimal when it is possible to make one person better off without making someone else worse off. Below we present a simple model of an economy in order to illustrate the notion of pareto sub-optimality. We assume that the utility (U) of a group of consumers is a function of goods consumed (X) and the disutility from the level of pollution (Q).

$U = U(X, Q)$ Welfare (1)

Pollution results from emissions (E) throughout the production of X. Production is based on usual inputs (I) and it is negatively subject to the level of pollution.

$X = X(I, E, Q)$ Production (2)

The level of pollution is a function of emissions of all sources.

$Q = Q(E)$ Pollution (3)

The below analysis is by the assumption that functions have the following properties:

$$dU/dX \succ 0,\ dU/dQ \prec 0,\ dX/dI \succ 0,\ dX/dE \succ 0,\ dX/dQ \prec 0,\ dQ/dE \succ 0 .$$

The maximazion of welfare of the consumers utility subject to conditions 1.2 and 1.3 leads to a set of the first order conditions. The fundamental first order condition referred to external effects is:

$$\partial U/\partial X \times \partial X/\partial E + \partial U/\partial X \times \partial X/\partial Q \times \partial Q/\partial E + \partial U/\partial Q \times \partial Q/\partial E = 0 \quad (4)$$

[1] The First Fundamental Welfare Theorem states that any competitive equilibrium is Pareto optimal and the Second Fundamental Welfare Theorem goes further saying that any Pareto Optimal Allocation can be achieved as a competitive equilibrium if appropriate lump-sum transfers of wealth are arranged.

$\Leftrightarrow$

$$\partial X / \partial E = -\frac{\partial U / \partial Q \times \partial Q / \partial E}{\partial U / \partial X} - \partial X / \partial Q \ \partial Q / \partial E \qquad (5)$$

where:

$-\frac{\partial U / \partial Q \times \partial Q / \partial E}{\partial U / \partial X}$: *Marginal damages the additional emissions impose on the consumers*

$-\partial X / \partial Q \ \partial Q / \partial E$: *Marginal damages the additional emissions impose on the producers*

Equation (1.5) states that production should be increased only to the level where the marginal product of emitting one unit more ($\partial X / \partial E$) equals the sum of the marginal damages the additional emissions impose on the consumers and on the producers utility. So, the Social Planer should define the optimal level of pollution from the equality between the marginal abatement costs to the marginal benefits from reduced pollution.

However, in competitive market firms without discharge use the natural resources. Thus, firms in order to maximize their profits produce until to the level where the private marginal return is zero ($\partial X / \partial E = 0$). In this level, firms define their production without estimating the negative effect of pollution on utility and production. When the natural resources have open access attributes, as the property rights (see below Coase theorem) are not correct defined, the level of production and pollution is too high and the prices of the polluting products- since they do not include the additional social costs which pollution creates- are too low.

Figure 2.1 illustrates the above mentioned. The MB (Marginal Benefit) curve shows the Marginal Benefits and the MC curve shows the Marginal Costs. In a competitive market without any regulation for natural resources firms would produce up to the point where the marginal benefits are zero ($\partial X / \partial E$ =0). The social optimum is at Q_1, where the MB is equal to MC.

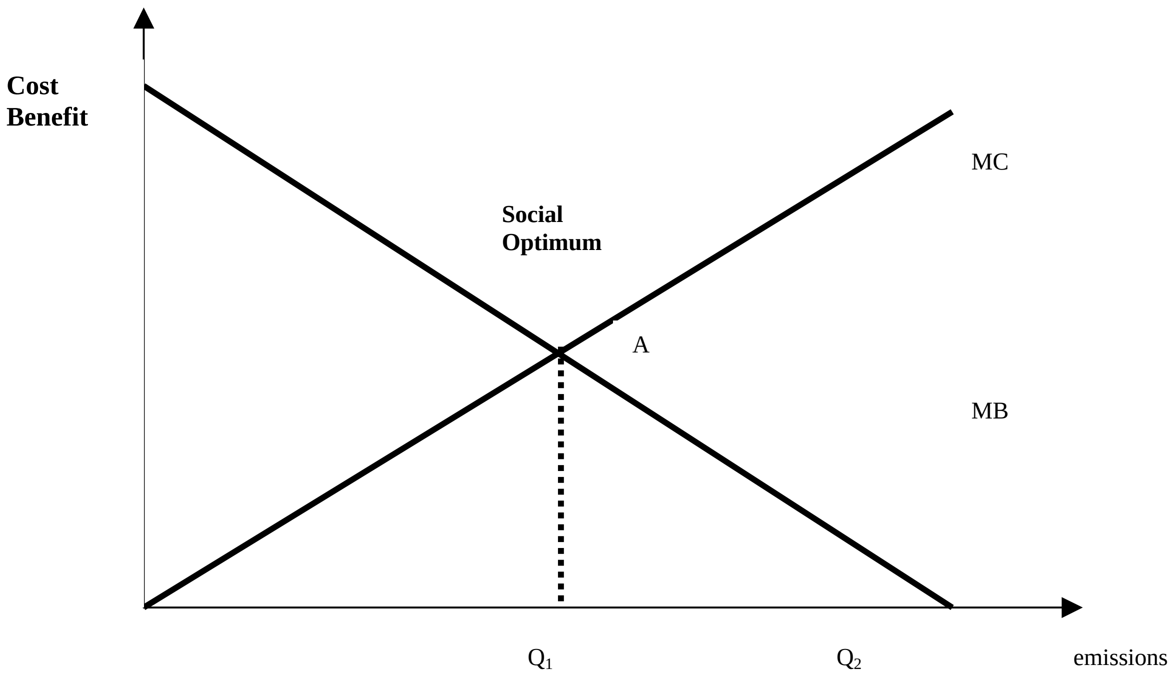

Figure 2.1: The Social Optimum amount of Emissions

2.2. The Coase Theorem

R.Coase firstly pointed the need of definition the property rights in 1960 at the fundamental article for economic science “The Problem of Social Cost”. The central idea of what is known as the “Coase Theorem” is that the presence of externalities may not always imply market failure. The affected parties could negotiate an optimal level of the externality generating activity in absence of any kind of interruption. As Dales[2](1968) states “property rights are the legally defined rights to use property in certain ways, to prevent others from exercising (exclusivity) these rights, and to sell the property (transferability). Many kinds of property can be distinguished as open access or common. The below analysis is focused on private and transferable property rights.

In particular, Coase showed that a bargaining solution will result in a Pareto-optimal allocation of the environment when follow assumptions hold:

1. If the transferable property rights (rights to emit in our case) are well defined and can be measured.
2. If transaction cost is zero and the knowledge is perfect.
3. If individuals maximize their utility.
4. If this allocation is independent of who has the initial distribution of property rights.
5. If the involved parties are two

Figure 2.2 shows an example of bargaining between a factory and a hotel. If the factory has the right to pollute, the level of pollution would be Q_M (the amount that maximizes the net private benefits-MNPB). The hotel (victim) however could pay the factory (polluter) to move to point Q*. Between Q_M and Q* the hotel would obtain gains that are sufficient to compensate the polluter. At Q* the victim improves its welfare (area Q^*EAQ_M) and the polluter is compensated (area EQ^*Q_M). The net gain in welfare would equal the area EAQ_M.

If the hotel has the right to a clean atmosphere, the starting point would be 0. In this case the factory could buy the right to pollute from the hotel. Between 0 and Q* the benefit to the factory of increasing its production exceeds the costs to the hotel. So, again the

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[2] Dales, J.H *Pollution, property and prices*, Toronto: University Press, 1968

bargaining follows the same procedure up to point Q* where the net benefits are maximized.

The Coase Theorem has accepted serious critique[3] because it based on non-realistic assumptions. Firstly, as the above example states, there are only two parties involved with perfect knowledge and the transaction costs are zero. In real world, in most cases of pollution we have more than one polluter and victim. Specifically environmental resources have free access and common property resources properties. Thus, the “environmental good” are considered as “public goods”. In this case, the free rider problem arises because polutees cannot be excluded from the benefits that result from a bargain between one pollutee and one polluter to reduce pollution. Moreover, if the pollutees have the initial rights to a clean environment, the polluter must negotiate and bargain with each of them in order to gain rights to emit up to the optimal level (Q*). Consequently, the transaction cost (as to identifying the polluters) are increased as the involve parties increase. It must be highlighted that in most times environmental matters cannot be represented from all parties as for instance future generations.

Although the Coase theorem fell to convince for its practical application is an important basis for most modern economic analyses of government regulation.

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[3] The failure to convince most economists has clearly frustrated Coase, as when he wrote: "My point of view has not in general commanded assent, nor has my argument, for the most part, been understood. As the argument in these papers is, I believe, simple, so simple indeed as almost to make their propositions fall into the category of truths which can be deemed self-evident, their rejection or apparent incomprehensibility would seem to imply that most economists have a different way of looking at economic problems and do not share my conception of the nature of the subject. This I believe to be true." Ronald Coase, *The Firm, the Market and the Law* (Chicago and London: University of Chicago Press, 1988), p. 1.

2.3. Emission Taxes

When an externality exists and the conditions of the Coase Theorem do not hold an instrument that leads to social optimum, at least in theory, is a Pigovian tax. The idea behind this recommended policy is that in terms of economic efficiency the polluter should pay the full cost of environmental damages caused by its activity. In 1920 Pigou suggested that polluters should face a tax based up on estimated damage caused by their pollution emission. Pigouvian taxes are one instrument for achieving the ‘Polluter Pays Principle’ (PPP), the principle that those who generate pollution should be the ones liable to pay the damage costs. It is notably that Pigovian taxes could control environmental externalities when individual emissions can be monitored.

According to figure 2.2, the tax would have to be equal to OT per unit of waste emissions. In this case the marginal net private benefit function (MNPB) of the firm, under perfect competition conditions would become MNPB’. Using this approach, the firm has incentive to restrict pollution to the optimal level Q*.

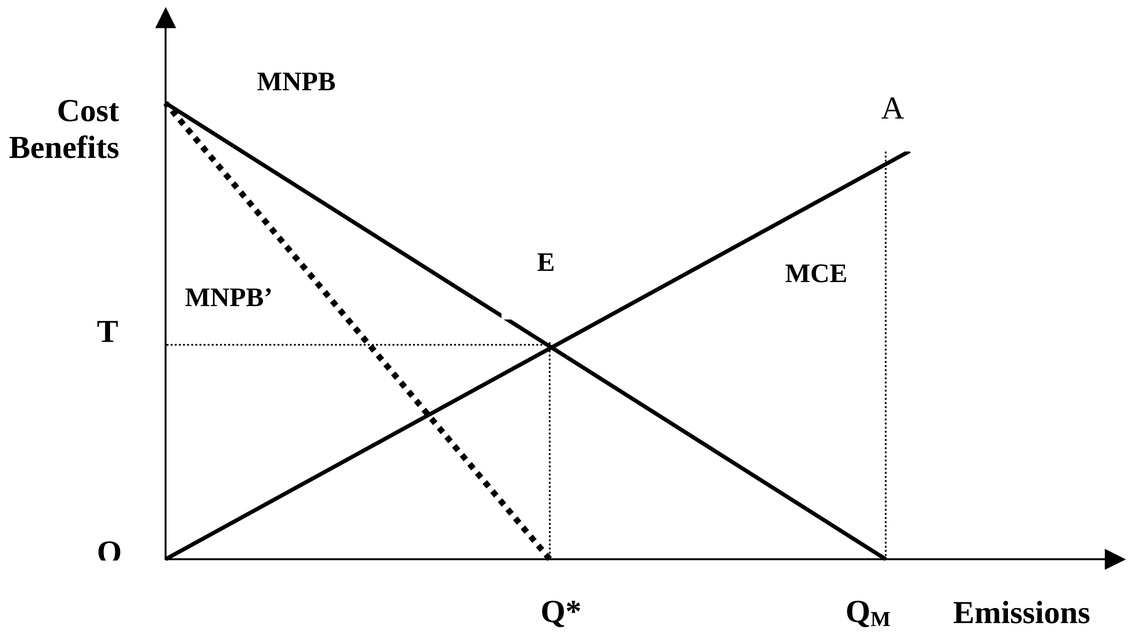

Figure 2.2: The optimum tax under production externalities

2.4. Uncertainty on costs and damage functions

Uncertainty is one of the most classical arguments for optimal charges. In particularly, the relationship between damage and emissions is considered as linear while the location of the source is irrelevant. In fact, when damage function is not linear "the optimal charge cannot be determined without knowledge at the cost functions"[4].

Under certainty different environmental policy instruments (quantity and price approaches) can attain the optimum:

- Emission charges: per unit of emission as it was already described.
- Standards: consisting of laws and regulations prescribing objectives, standards and technologies polluter must comply with – this approach of regulation is called "Command and Control (CAC)".

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[4] Bohm, P., Russell, C.S. "Comparative analysis of alternative policy instruments", in Kneese A.V. and J.L. Sweeney (eds) Handbook of natural resource and energy economics, vol 1, Elsevier Science Publishers, Amsterdam, pp.395-460, 1985

- Tradable emission permits: a system which allowing the involved parties to buy and sell permits (rights to pollute). The environmental agency should define the total quantity of emissions at the optimal level as in case of Pigovian tax.

In contrast, if the cost and damage functions are uncertain the equivalence between environmental instruments does not hold as Weitzman in 1974 proved. Two kinds of uncertainty could be distinguished. Firstly, uncertainty about the marginal damage functions that it does not seem to affect the welfare loss. Secondly, uncertainty about the marginal benefit functions (as technological uncertainty) that affects the welfare loss as it influences its instrument differently.

Figure 2.3 illustrates an example with uncertainty in the benefit function. Let us assume that MB is the marginal benefit function and MD is the marginal damage function. Environmental agency could either set the optimal tax level at t or fix the total number of emission rights at $\bar{e}$. Under perfect information conditions the impact on welfare would be the same. But, if the true marginal benefits (MB') were to be different from MB, the welfare impacts of taxes and tradable permits would differ. On one hand, given the emission tax t polluters would generate emissions beyond the optimal level e* to the point $e_{0,}$ since they would equate the true marginal costs with the tax level. On the other hand, with tradable permits, total emissions would be lower that in the true optimum ($\bar{e}$) and the permit price would increase to $T_{u.}$

Thus, taxes result to a loss of ADE while tradable permits results in a loss ABC.

In particular example, the welfare loss of tradable permits exceeds that of emission charges. The slope of the marginal damage and marginal benefit functions defines whether or not welfare losses under an emission charge exceed those of a tradable permit system.

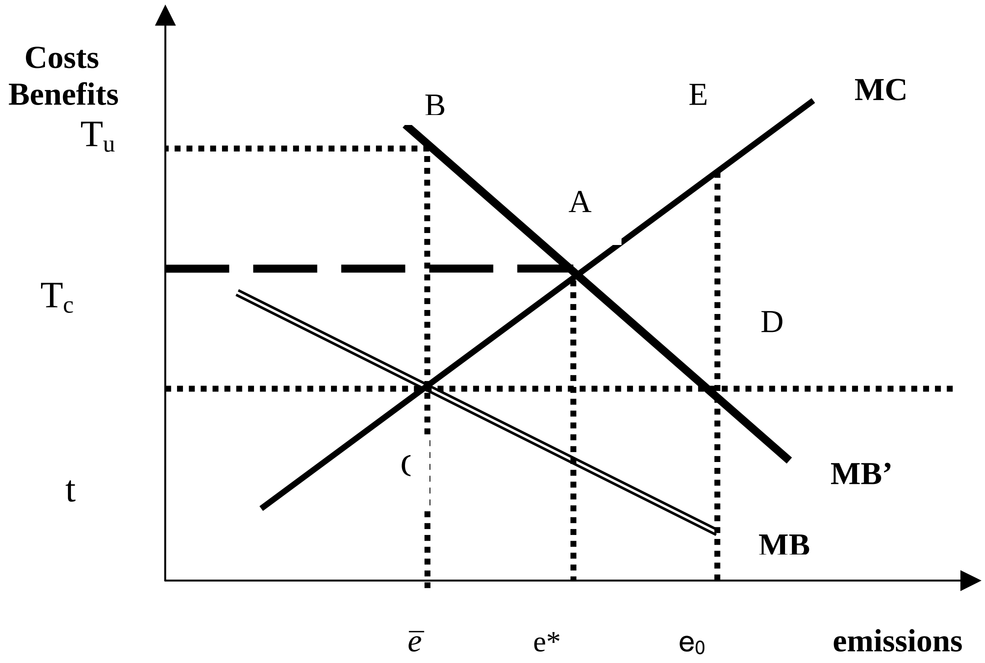


Figure 2.3
Welfare loss under uncertainty in the benefit function

2.5. Tradable Permits

In a market economy, most of economists would in fact prefer a pricing system fixed by the market and not by the government. In 1968 the Canadian economist Dales stated "that markets could be used to implement any anti-pollution policy"[5]and suggested the creation of a number of rights to discharge one unit of waste during a certain period with the option of auctioning off these rights. The basic idea was that some firms might find it more profitable to reduce their emissions and to buy fewer rights than others. The market for rights to pollute will be in equilibrium when the price is high enough to reduce demand.

[5] Dales, J.H *Pollution, property and prices*, Toronto: University Press, 1968, p.100

A system of tradable permits could be designed in the following way. Firstly, it is necessary the definition of an emission permit in terms of an allowable rate per year or period. Secondly, a central environmental agency that is responsible for the environmental management of a region determines the total amount of pollution permits (L) according to past objectives and future trends. Thirdly, the environmental agency distributes or sells 'pollution permits'. The finally allocation of pollution permits depends on the market laws (demand and supply). The distribution of pollution permits could be by "grandfathering" – the pollution permits are allocated for free according to emission levels in the past- or by auctioning – is a way of selling pollution permits to any interested party (natural or legal).

It can be proved that, under a number of restrictive assumptions, the emission trading scheme can be the least – cost solution to regulate environmental externalities. These assumptions are that the market of tradable permits is competitive, that involved parties minimize their control cost and that transaction costs are low.

For instance, if the initial permits of industry i is L_i^0 and the price of the permit P, each industry in order to maximize its profits should minimize its costs. Costs are the sum of pollution control costs plus the cost of buying additional permits:

$$C_i(R_i) + \mathrm{P}\left[\left(\overline{E_i - R_i}\right) - L_i^0\right] \qquad (7)$$

The first order condition for a cost minimization requires that:

$$dC_i(R)_i \big/ dR_i - P = 0$$

or (8)

$$dC_i(R)_i \big/ dR_i = P$$

Where:

$\overline{E}_i$: the uncontrolled emissions source i

R_i : the amount of emission reduction by source i

$\overline{E}_i \geq R_i \geq 0$: the minimum costs of reducing emissions for each source.

Furthermore $\overline{E}_i \geq R_i \geq 0$. That is, emissions and reductions are nonnegative.

The cost function is concave. The marginal costs increase with further emission reductions.

$C_i^{'}\left(R_i\right) \succ 0$, $C_i^{''}\left(R_i\right) \succ 0$

It is notable that under perfect competition there would be only one price leading to equal marginal cost for all polluters. Thus, the cost minimum for each industry i is achieved to the point where its marginal cost of emission reduction is equal to the market price of the permit.

Imagine two industrial plants that emit CO_2 into the atmosphere. Each has different costs of controlling emissions: the cost of controlling one tone CO_2 in plant 1 is 18 € per tone, and in plant 2 is 28 € per tone. These marginal costs are shown by the height of the two blocks in the diagram. Now suppose the regulator uses a command and control solution and requires both plants reduce emissions by one tone, a total reduction of two tones. The cost for plant 1 is18 € and the cost for plant 2 is 28 €. So, that overall compliance costs are 40€. Emissions are now two tones less (in total 50 tons).

Suppose now that regulator issue permits for 50 tones of CO_2 emissions (figure 2.4). Plant 1 and plant 2 are both 'equal' polluters because each emits twenty-five tones of pollution. The regulator therefore decides to allocate the fifty tones allowance equally between plants. Each industry is free to trade its permits. This means that the permits will attain a market value because they can be bought and sold. Let the resulting market price be 22€ per tone of CO_2 as shown in figure 2.4. Plant 1 can reduce a tone of CO_2 at cost of only 18 €. Plant 2 has incentive to pay Plant 1 to reduce emission below the number of permits it has. Cost savings can be achieved if plant 1 abates more than plant 2. For example, if the emission limit is strengthened by one tone CO_2 for plant1 and lowered by one tone for plant 2, a total cost saving of 28-18=10€ is achieved. So, Plant 2 will happily buy permits until its marginal costs decreases to market price (22€). The end result is that plant 1 sells permits until its abatement costs equals permits price (it sells 15 tones CO_2) and plant 2 does not cut at all (it buys 15 tonnes CO_2). But this what the regulator wants – the stabilization of CO_2 emissions to 50 tonnes in total. So the level of environmental quality is as good as it would be under the CAC (Command – And-Control) approach. But, interestingly, both plants have gained through the permit trade.

In theory the system of tradable permits is considered as ideal as it is less costly and the total quantity of pollution is predefined. However in practice tradable permits have appeared a number of difficulties in their application. Firstly, the method off initial allocation (grandfathering or auctioning) as it determines the future polluters have the tension to consolidate the use of environment from the present polluters.

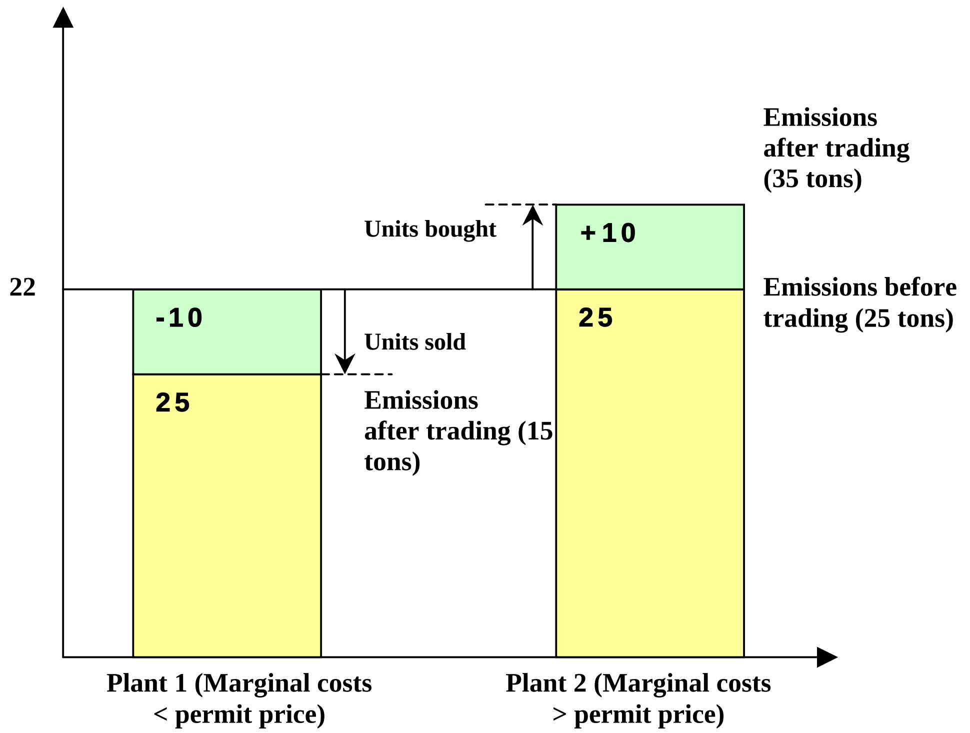


Figure 2.4: Cost minimum achievement under emissions trading

Secondly, such systems used to be too complex and create high transaction costs. Transaction costs caused by firms when trading requires information or bargaing and decision costs. “Like a direct tax, transaction drive wedge between the price paid by the buyer and the price received by the seller”[6]. The sulfur allowance program to facilitate the transaction costs established the auction market[7]. As a result this market, “by providing information on prices reduced transaction costs, has the effect of lowering the spread between the highest bid and the clearing price. Specifically, the spread has dropped from $319 (in 1993) to $14 (in 1997) indicating the effect of public knowledge of price information”[8]. Stavins[9] shows that in the presence of transaction costs, permit markets may not be fully cost-effective. In particular, the existence of transaction costs impedes some cost-saving trades to realize. Transaction costs prevent the total correction of any initial deviations from the least cost allocation.

Thirdly, the existence of market power is one of the fears expressed almost in any new discussion of transferable permits. One type of market power is the ability of a firm to manipulate permit prices strategically either as a monopolistic seller or a monopolistic buyer. Another type of strategic behavior occurs when firms use the permit market to drive competitors out of the business. In practice this problem is quite rare. In cases that market power problem is possible to appear the proper program design can restrict its negative consequences. Finally, it must be taken into consideration when it is designed a system of tradable permits that although allowances can be both borrowed and banked, it

[6] Nicolson, W. *Microeconomic Theory : basic principles and extensions.* Dryden Press, Chicago, 1989, pp.418-420
[7] Unfortunately, the auction design creates some incentives for inefficient strategic behavior
[8] Tietenberg, T. “Tradable Permit Approaches to Pollution Control: Faustian Bargain or Paradise Regained?” CT: JAI Press Inc, 1999
[9] Stavins, R., and R. Hahn. “ Transaction Costs and Tradable Permits”, *Journal of environmental Economics and Management* 29 (20): 133, 1995

is possible for emissions to be concentrated in time. However, the concentrated emissions create more damage than dispersed emissions and it is necessary the a priori restrictive regulation.

The U.S Environmental Protection Agency (EPA) first applied the concept of marketable emission permits in the mid-1970s. However, the most important trading application ever made is Acid's Rain Programs system of marketable pollution allowances for sulfur dioxide (SO_2). This was a cap-and-trade program[10] and it was highly successful at achieving cost-effective emissions reductions.

[10] Under a cap-and-trade policy provides control over total emissions and allocates them among firms in the form of permits.

3. Global emissions and the Kyoto Protocol

3.1 The greenhouse effect and climate change

Nowadays, the existence of global warming requires the adoption of policies in order to prevent its negative impacts. Many countries have already taken active policies against the over-exploitation of the atmosphere that causes the climate change.

Global warming describes an increase in the average temperature of the Earth's atmosphere and oceans. The average temperature of the earth's surface has risen by 0.6 degrees C° since the late 1800s. Natural events and human activities are believed to be contributing to an increase in average global temperature as for example the burning of ever-greater quantities of oil, gasoline, coal and the cutting of forests. Human activities have increased the amount of "greenhouse gases" in the atmosphere, such as Carbon Dioxide (CO_2).

In particular, solar energy arrives to the earth in the form of radiation. About 30 per cent of sunlight is reflected back into space by the outer atmosphere, but the rest reaches the earth's surface and warms our planet. Some atmospheric gases, which are called greenhouse gases[11], trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Greenhouse gases create two forms of greenhouse effects. Firstly, the natural greenhouse effect, which refers to the greenhouse effect which occurs naturally on earth and secondly the enhanced (anthropogenic) greenhouse effect, which results from human activities. Human activities are making the blanket "thicker" and rising the average global temperature. The Third Assessment Report of

[11] The Kyoto Protocol focuses on six GHG: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydroflurocarbous (HFCs), Perfluorocarbous (PFCs) and Sulphur Herafluoride (SF_6). All GHG have different Global Warming Potential (GWP). A GWP is a measure of the relative effect of a substance in warming the atmosphere over a given period. In order to facilitate and simplicity, reduction targets under the Kyoto Protocol are measured in tons of CO_2 equivalent Global Warming Potential.

the Intergovernmental Panel on Climate Change (IPCC) focuses on “new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities”. The IPCC predicts a rise of 1.4 to 5.8 ^{o}C in earth’s surface the next years. Thus, it is necessary to minimize the enhanced greenhouse effect as the earth might become less habitable for human, plants and animals if it becomes warmer.

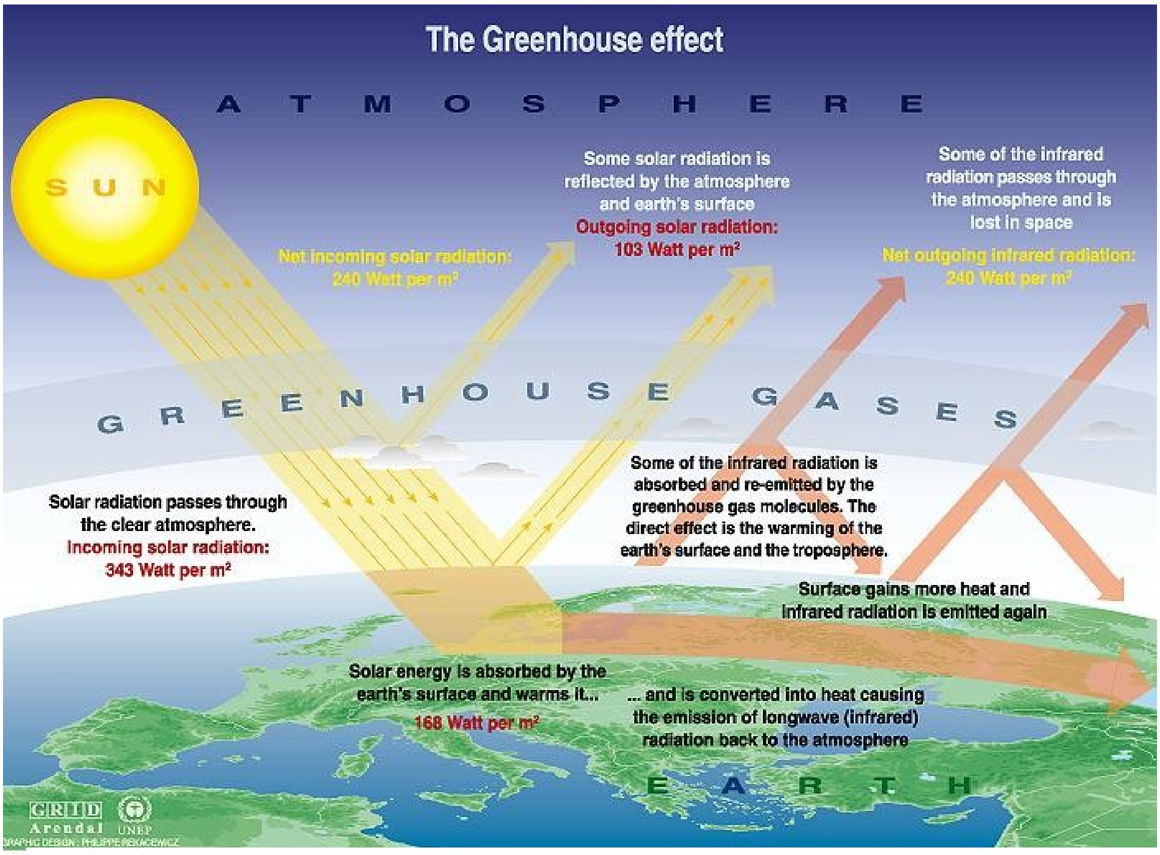


Figure 3.1: The Greenhouse Effect (reproduced from UNFCCC, 2003)

3.2. The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

The relationship between climate change and human activity was first emerged in the international public arena in 1979 at the first World Climate Conference. In 1988 the United Nations General Assembly adopted a resolution 45/53 for the “protection of global climate for present and future generation of mankind". In the same year, the World Meteorological Organization (WMO) and the United Nations Environment Programme created a new body, the IPCC to provide scientific information on the subject of climate change. The First Assessment report of IPCC in 1990 confirmed the need for a global cooperation to address the problem of climate change. The Ministerial Declaration in the second world climate conference held in Geneva later that year echoed this need. Under the call for the creation of a global treaty in December of 1990 the General Assembly established the Intergovernmental Negotiating Committee (INC). In February of 1991 was the first meeting of INC and after negotiations was adopted the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was entered into force on 21 March 1994 and considered as one of the most universally supported environmental agreements as 188 states and the European Community had joined it[12].

The principal objective of the convention is "…to achieve stabilization of atmospheric concentrations of greenhouse gases at levels that would prevent dangerous anthropogenic (human – induced) interference with the climate system…"[13]. The convention divides countries into three main groups:

Annex I[14] : These are industrialized countries belonging to the OECD (Organization for Economic Co-operation and Development) in 1992 and the so called Economies in Transition (EIT) which include Russia, the Baltic States, and several Central and Eastern European States. The parties of Annex I have main target to reduce or limitate the GHG emissions. More specifically, it is expected that the achievement of these targets to lead

[12] Appendix 1 has a full checklist that reproduced by the UNFCCC " Caring for climate", 2005
[13] It is stated in article 2 of the Convention.
[14] Appendix 2 has a list of total aggregate greenhouse gas emissions of individual Annex I Parties, 1990-2002.

to a reduction at least 5 per cent on emissions of GHG compared to 1990 levels for the first commitment period 2008-2012.

Annex II : These are the same countries as Annex I, but excluding the EIT parties. They represent the most industrialized countries, which are responsible for large historic and present emissions. According to article 4.5 of the UNFCCC " …Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other parties, particularly to developing countries to enable them to implement the provisions of the convention…"

Non Annex I : These are countries not included in Annex I. Non-Annex I parties are not obliged to submit an annual emission inventory as their policy to address climate change is defined in more general terms. We can divide Non Annex I parties into two groups: the LCDs (least developed countries) and other developing country Parties to the Convention.

The countries that have ratified and accepted the convention they have met annually at the Conference of the Parties (COP). The aim of COPs is to continue negotiations on how to monitor climate change. At the third COP (cop3), held in Kyoto, Japan in 1997, the parties agreed to bind commitments to emissions cuts. This Kyoto Protocol described in general the basic rules and required ratification by government before it could enter into force. In 2001, at CoP 7 in Marrakech was adopted the famous "Marrakech Accords" which provided more detailed rules for the implementation of the Protocol. In particular, it was decided that the protocol could enter into force if at least 55 parties of the convention has ratified it. In 1998 the Protocol was ratified for first time and was entered into force on 16 February 2005 after the Russia Federation ratification on 18 November 2004.

Figure 3.2 reveals that as Annex I countries produce the largest emissions compared to the non Annex I countries, it is expected their contribution to reduce GHG emissions to provide significant effects.

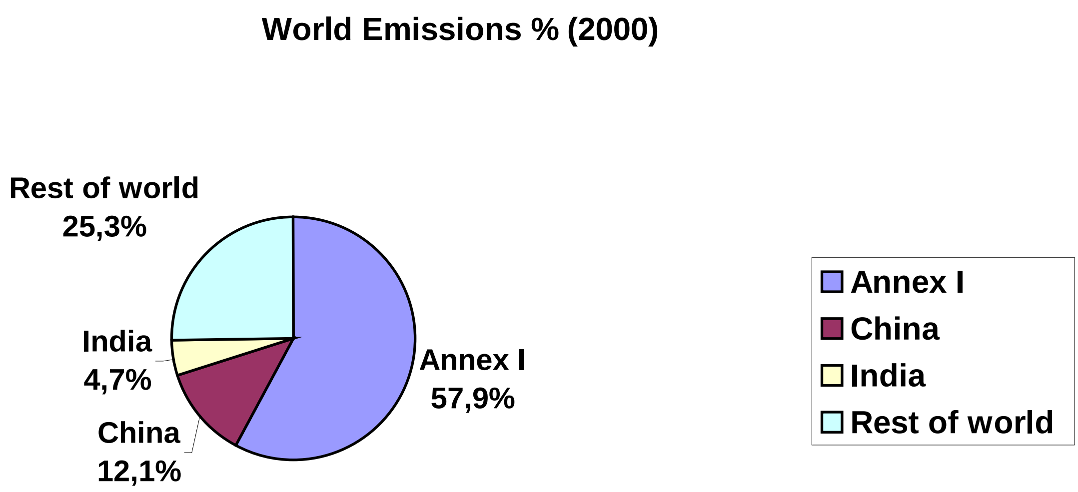


Figure 3.2[15]

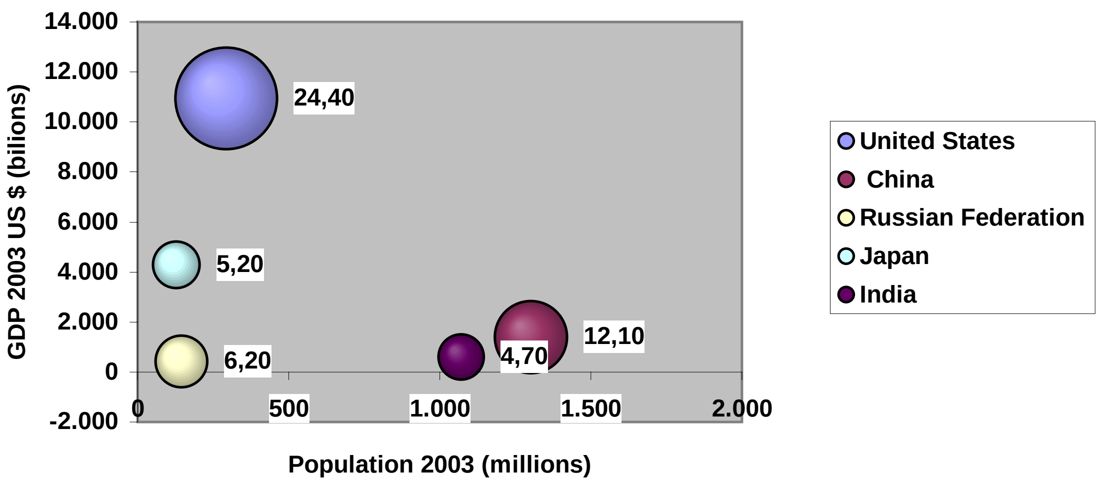
The targets for Annex I Parties are listed in Annex B to the protocol. An estimation made by the International Energy Agency (IEA) shows that the share of Annex B parties in global CO_2 emissions was about 57,9 percent. It is expected that if Annex B parties succeed in the GHG reduction, they would lead to a total reduction in their emission of about 5 percent[16]. In order to control anthropogenic emissions it is necessary to examine emissions in combination with two more variables that are related to climate change:

[15] Own elaboration is based on Watkins, K. & ecl, *Human Development Report 2005- International cooperation at a crossroads,* The United Nations Development Programme, New York, 2005.
[16] These reductions do not take into account of Australia and the United States, which have stated they do not intend to ratify the protocol.

Population and Gross Domestic Product (GDP). From figure 3.3[17] it is obvious that: 1. Although that Russia have similar population, Russia has almost 60 times lower GDP. So, it must be noted that pollution and economic growth are not always interrelation notions. According to bibliography it accepted that under certain conditions economic growth and environmental protection could walk together. Furthermore, Russia has seven times lower population than India and it produces almost the same level of emissions. It is notable that CO_2 emission per capita in Russia (9,9) is almost nine times higher than India (1,2). 3. Additionally, the USA has approximately double emissions than China, while China has almost four times higher population and 9 times lower population than the US.

The above remarks are very important as they bring up for discussion that in order to address to reduce GHG concentrations, the international community should establish measures and policies taken into consideration such issues as equity and sustainable development.

Figure 3.3:Top Five Emitters



[17] Appendix 3 presents the Carbon, emissions, Population and Gross Domestic Product in OECD countries.

3.3. The Kyoto Mechanisms

The Kyoto protocol authorizes three cooperative implementation mechanisms in order to improve the cost-effectiveness of the emissions reductions measures. These include Clean Development Mechanism, Joint Implementation and the Emission Trading.

- **The Clean Development Mechanism (CDM)**

The CDM enables Annex I countries to implement sustainable development projects activities that reduce emissions in non-Annex I Parties. Not only does CDM help the non-Annex I Parties but it also provides the investing party with Certified Emission Reductions (CERs) to help them to meet their own targets. Furthermore, CDM projects must be approved by all involved parties and yield real long-term benefits to global warming mitigation. The Kyoto protocol enables parties to receive CERs from the year 2000 onwards, if the related projects address the CDM requirement.

- **Joint Implementation**

Joint Implementation gives the opportunity to Annex I Parties to implement projects that reduce emission, or increase removal using sinks[18], in other Annex I countries. In that case, the investing party receives additional Assigned Units, which are called Emission Reduction Units (ERUs). In order to avoid double counting, a corresponding subtraction is made from the host Party’s assigned amount. JI projects are most likely to happen in EIT countries. As CDM projects, JI projects must have the approval of all parties involved and yield emission reductions.

[18] The concept of sink relates to ways to storage carbon, like accumulation in the forests or in oceans

- **Emissions Trading**

In order to reduce the overall cost of mitigating climate change, Kyoto Protocol provides to Annex I Parties the capability to trade the assigned amount units (AAUs). By this way, Annex I Parties are able to rein emissions or increase removal. An emissions trading market must follow the below principles:

- Each Annex I Party is obliged to hold a minimum level of credits at all time. It is calculated a 90 percent of the Parties assigned amount or as the amount of emissions reported in its most recent emissions inventory.
- Parties must establish an independent national registry to record emissions and to monitor the tool of tradable permits.

The Kyoto Protocol establishes four types of emissions trading:

- Article 17 states"the Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under the Article 3". So, Article 17 authorizes the trading of "assigned amounts" among the Annex B nations.
- Articles 6 and 12 propose mechanisms which provide emission reduction units by Annex I parties and certified emissions reductions by non-Annex I parties (under the clean development mechanism-CDM).
- Article 4 allows parties to act jointly in order to fulfill their commitments under the article 3 ("bubbles"). provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions do not exceed their assigned amounts.

3.4. Emissions Trading under the European Union

European Union used to support the international efforts to mitigate the environmental degradation. Not only do the European Member States be parties of the convention but the European Community itself also can be as a regional economic integration organization. However, it does not have a separate vote from its members. The European Union countries ratified the protocol in May 2002, committing to reduce emission by 8% from the level of 1990 for the first commitment period (2008-2012).

The European Union decided to reallocate its targets among its members, taking advantage of a scheme under the protocol known as a "bubble". These targets range from a 28% reduction by Luxembourg to 27% increase for a Portugal[19]. Under the burden sharing agreement Greece has a target of +25% of 1990 emissions levels for the First Commitment Period.

[19] In addition to the Kyoto targets some countries have set stronger national emissions targets for themselves, such as the UK (-20% of 1990 CO_2 levels 2010) and Sweden (-4% by 2010).

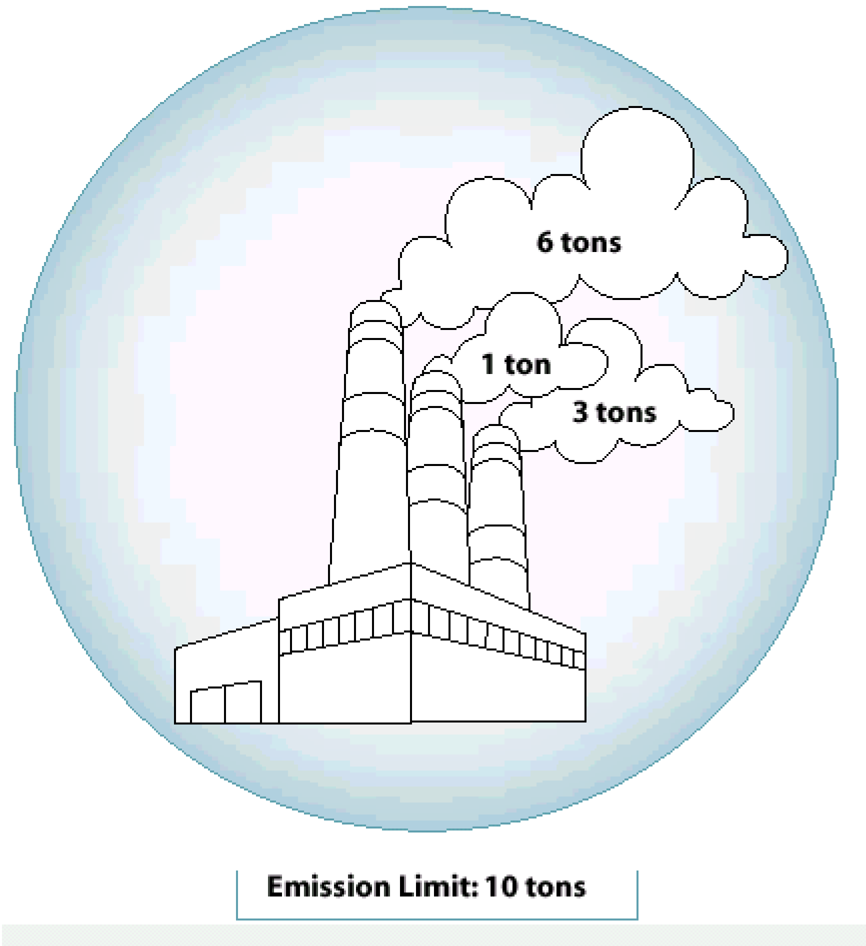


Figure 3.4: Bubble Policy

3.4.1. The European Climate Change Programme (ECCP)

The European Union in order to address the Kyoto targets launched in March 2000 the European Climate Change Programme (ECCP). The ECCPs aim is to classify and develop cost-effective measures that will increase the ability of EU to meet its (-8%) Kyoto target.

The ECCP was separated into two phases:

In the first phase of ECCP (2000-2001) the aim was to develop additional policies and measures concentrate on the energy, transport and industry sectors. A number of working groups were formed, each of them considering to particular subjects.

- Working Group 1 (WG1): The flexible mechanisms of the Kyoto Protocol – emissions trading, Joint Implementation and the Clean Development Mechanism
- Working Group 2 (WG2): Energy supply
- Working Group 3 (WG3): Energy Consumption
- Working Group 4 (WG4): Transport
- Working Group 5 (WG5): Industry
- Working Group 6 (WG6): Research
- Working Group 7 (WG7):Agriculture

According to the Report of ECCP in June 2001 the main corollary is "that to minimize the overall cost of the EU climate policy for society as a whole (consumers and producers) every sector should contribute to the objective of the Kyoto Protocol while the precise intensity of the emission reduction effort needs differentiation. Therefore it would not make sense from a least-cost perspective for each sector to undertake an emission reduction of 8%. Rather this objective needs to be reallocated over the different sectors through a cost-effective set of policies and measures"[20]. Annex 1 of the report presents a full table in which each working group proposed measures, including emission reduction potential, costs and timings. In particular, it was estimated that EU can reduce approximately 664 to 765 Mt CO_2 eq at a cost less than 20€/tonne.

The report of the ECCP classifies the proposed measures into three categories. Measures that:

[20] European Climate Change Programme – Report June 2001. European commission (June 2001). The report can be downloaded at < http://www.eceee.org/library_links/downloads/ECCP/eccp_report_0106.pdf.>

1. are “mature” by meaning the measures that are at an advance stage of preparation. This category provides eight measures, including the development of an Greenhouse Gases Emissions Trading Scheme
2. are “in the pipeline” by meaning the measures that are in less mature stage. This category contains eleven measures
3. are sought more detail work. This category proposes twenty-three measures.

Following on from the ECCP Report, in October 2001, the Commission brought forward a package of three broad measures to tackle climate change:

1. An Action Plan for the ECCP

Firstly, the Action Plan took the form of a Communication from the Commission containing priority actions which laed to emission reduction potential of 122-178 Mt Co2eq.

2. Proposal for ratification of the Kyoto Protocol

Secondly, at the same time, the Commission propound a proposal for a Council decision on the ratification of the Kyoto Protocol. The EU ratification of the protocol implemented in May 2002.

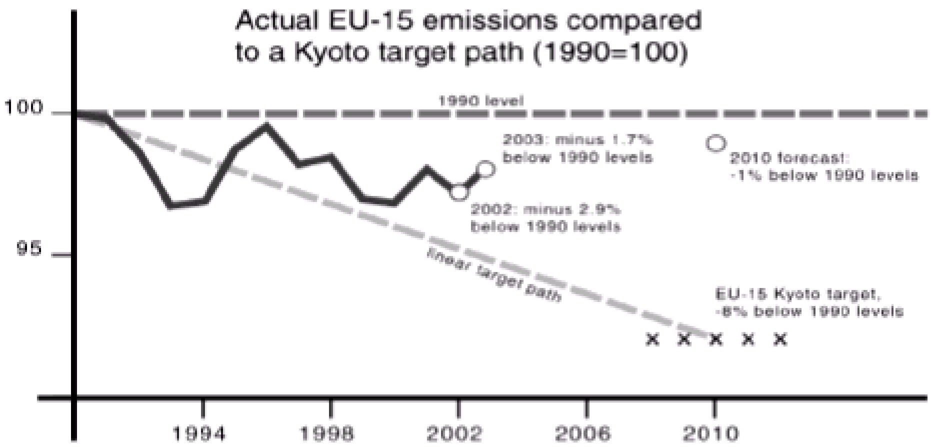
3. ***Proposals for Emissions Trading***

Thirdly, the Commission proposed a Directive on Greenhouse Gas Emissions Trading. The EETS enables certain businesses and industries to trade their allocations for CO_2 emissions and is expected to start in 2005. The above proposal as the core of the national allocation plans and their applicability is further discussed below.

In the second phase of ECCP (2002-2003) aim was to facilitate and support the actual implementation of the priorities identified in the first phase. In particular forty two potential reduction measures have been identified with a total emission reduction potential of up to 700 million tonnes of CO2 equivalent and at a cost of less than €20 per tonne of CO2 equivalent.

Unfortunately, current evidences shows that in number of EU countries emissions trends are not in line with Kyoto targets. In 2003 the European Environmental Agency reported[21] that in 2003 emissions of the EU-15 were 1.7% below 1990 levels, while they should have been at minus 5.2% if compared to a linear reduction path in order to meet the requirements of the Kyoto Protocol.

Figure 3.4[22]



It is notable that the energy sector is the largest contributor of CO2 emissions in Europe. Recent studies have shown that a reconstruction of the energy sector can lead

[21] EEA Technical Report No 4/2005, Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005; EEA June 2005, available at http://reports.eea.eu.int/technical_report_2005_4/en
[22] Source: Greenhouse gas emission trends and projections in Europe 2004; EEA 2004 with emissions figure for 2003 from data released in 2005.

to reduction of the EU's annual CO2 emissions from about 3,600 Million tonnes in 2000 to 1,020 million tonnes in 2050, with a phase-out of nuclear power included[23].

In case of Greece according to the 2nd National programme for climate change predicted the extended use of natural gas electricity generation units by 2005, so that the contribution of natural gas in the sector is considerably increase and the electricity generation by lignite is limited accordingly. However, the delays in the electricity market liberalization led the extended use of natural gas units to become feasible from 2008 and afterwards.

3.4.2. EU Directive establishing the European Emissions Trading Scheme (EETS)

The Directive enabling the European Union (EU) to come into effect was approved in 2003[24] and started to operating officially in January 2005. The EU Emission Trading Directive is a step towards the Achievement of the Kyoto targets, according to which, each Member State of the European Union must develop and submit to European Commission a National Allocation Plan (NAP) for the three-year period 2005-2007. The content of EETS is presented below:

- The Directive 2003/87/EC regulates the activity of certain installations on the sectors of energy, production of ferrous metals, mineral industry, and industries of pulp and paper that throw off a certain threshold of CO_2 emissions[25]. From 2008 Member States may apply emission allowance trading in accordance with this Directive to activities, installations and greenhouse gases which are not listed in Annex I[26]

[23] Greenpeace, Energy Revolution: A sustainable pathway to a clean energy future for Europe, http: www. Eu.greenpeace.org/issues/energy.html, September 2005.
[24] Directive 2003/87/EC of the European Parliament and of the council establishing a scheme for greenhouse gas emissions allowances trading within community and amending Council Directive 96/61/EC.
[25] These categories are defined in detail in Annex I of Directive 2003/87/EC
[26] According to Article 24 of Directive 2003/87/EC

- The biggest challenge faced in operatinalizing the EU Trading Scheme has been the development of the National Allocation Plan (NAP). A member states Nap defines the cap on emission allowances for sectors (installations) included in the trading scheme and the specific allocation rule for the grandfathering. Annex III of the emissions trading Directive prescribes the criteria for the implementation and development of NAPs, these are:

1. The total quantity of allowances shall be consistent with the Members States obligation and with the national climate change Program.
2. Consistency with assessments of actual and projected progress towards fulfilling Member State contributions to meet overall EU targets.
3. Consistency with potential of activities covered by this scheme to reduce emissions.
4. Consistency with other legislation.
5. The plan shall no discriminate between sectors or companies.
6. The plan shall contain information on the manner in which new entrants will be able to begin participating in greenhouse gas emission trading.
7. Information on whether early action by participants will be provided for in the initial allocation process and if so how this is to be taken into account.
8. The plan shall contain information on the manner in which new clean technology including energy efficient technologies are taken into account.
9. The plan shall include provisions for comments to be expressed by the public, and taken account of in the plan;

10. A list of installations covered by the Directive with the quantities of allowances intended to be allocated to each, shall be included in the plan.
11. The plan may contain information on the manner in which the existence of competition from outside the EU will be taken into consideration.

- According to Article 10 “for the three year period beginning 1 January 2005 Member States shall allocate at least 95% of the allowances free of charge. For the five-year period beginning 1 January of 2008 Member States shall allocate at least 90% of the allowances free of charge. Allowances shall be valid for emissions during the period referred to in Article 11 (1) or (2) for which they are issued[27].
- Member states shall ensure that emissions are monitored and to establish a verification mechanism to control reporting from operators[28]. In addition each Member State shall provide for the establishment and maintance of a registry in order to ensure the accurate accounting of the issue, holding, transfer and cancellation of allowances. Any person could hold allowances[29]. The registry will be accessible to the public in detail. The Commission shall designate a Central Administrator[30], who conducts an automated check on each transaction log and to ensure the transparency of the application of EETS.
- Member States shall ensure that any operator who does not surrender sufficient allowances by 30 April of each year to cover its emissions during the preceding year shall be held liable for the payment of an excess emissions penalty. The excess emissions penalties shall be € 100 for each tone of carbon dioxide equivalent emitted by that installation for which the operator has not surrendered allowances. During the

[27] Article 13 of Directive 2003/87/EC determines the validity of allowances
[28] According to Articles 14 and 15 of Directive 2003/87/EC
[29] According to Article 19 of Directive 2003/87/EC
[30] According to Article 20 of Directive 2003/87/EC

three-year period beginning 1 January 2005 the penalty is € 40. Payment of the excess emissions penalty does not negate the obligation to surrender an amount of allowances equal to those excess emissions.

- Article 25 recognizes the need of creation links with other greenhouse gas emissions trading schemes. In particularly states: “Agreements should be concluded with third countries listed in Annex B to the Kyoto Protocol which have ratified the Protocol. It should be noted that linking the community scheme would increase the cost-effectiveness of achieving the Community emission reduction target (-8%)

4. Case Study: Greece

4.1. Decision 2002/358/EC and National Emission Policy

With respect to Kyoto Commitments, the Greek government developed and adopted in 2002 (Ministerial Council Act 5/27-2-2003) the 2nd National Programme for Climate Change. The aim of the 2nd national programme for climate change was to fulfill its national obligations under the Kyoto Protocol during the first commitment period (2008-2012), that is to limit **the increase of greenhouse gas emissions to 25% during the aforementioned five year period compared to base year emissions.** Given the fact that Land Use Change and Forestry (LUCF) sector was a sink for greenhouse gas emissions in 1990, greenhouse gas removals by this sector are not taken into account when calculating the Assigned Amount for the country during the first period of commitment under the Protocol (2008-2012), according to Article 3.7 of the Protocol. As a result, according to the most recent results of the Greenhouse Gas Emissions Inventory, **base year emissions for Greece are estimated to be 110,212.31 kt CO_2 eq**.

The total quantity of greenhouse gas emissions allowed in Greece during this five-year period is calculated from the base year emissions and the emission reduction target (25% of base year emissions). Therefore, according to the above, total greenhouse gas emissions in Greece during the period 2008 – 2012 **shall not exceed 688,826.94 kt CO_2 eq** (5 × 1,25 × base year emissions). In order to simplify calculations, the emissions reduction target (25%) is assigned to the year 2010. As a result, the **ceiling for annual emissions for that year is** taken to be **137,765.39 kt CO_2 eq** (1,25 × base year emissions).

Table 4.1: Total GHG emissions (in kt CO_2 eq) by IPCC sectors for the period 1990-2002

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
A. Greenhouse Gas Emissions / Removals per Sector													
Energy	80996	81035	82933	82874	84862	84622	87217	91802	96777	96035	101636	103881	103998
Industrial Processes	9140	9034	8784	9309	9791	11520	12173	12736	13085	13718	12879	12479	12526
Solvent and Other Product Use	170	176	172	169	162	153	151	152	151	159	145	155	155
Agriculture	13603	13389	13182	12584	12822	12573	12864	12578	12439	12456	12425	12216	12175
Land – Use Change and Forestry	-3440	-3815	-3240	-4054	-3736	-4614	-4217	-4159	-3705	-4671	-3211	-5545	-5701
Waste	4044	4072	4225	4350	4554	4651	4797	4917	5155	4555	4617	4556	4609
Total without LUCF	107953	107707	109298	109285	112190	113520	117202	122185	127606	126924	131701	133287	133464
Total with LUCF	104513	103892	106057	105231	108455	108905	112985	118026	12396	122253	128490	127741	127763
B. Greenhouse GasEmissions per Gas (without LUCF)													
CO_2	83905	83736	85296	85324	87168	87497	89795	94526	99133	98512	104072	106244	106172
CH_4	8715	8716	8883	9021	9284	9418	9728	9840	10166	9504	9644	9638	9787
N_2O	14140	13890	13958	13149	13436	13152	13691	13459	13434	13341	13564	13468	13418
HFC_S	935	1107	908	1638	2209	3369	3916	4194	4669	5435	4272	3845	3999
PFC_S	258	258	252	153	94	83	72	165	204	132	148	91	88
SF_6	Not estimated												
Total	107953	107707	109298	109285	112190	113520	117202	122185	127606	126924	131701	133287	133464
C. Greenhouse Gas Emissions /Removals from LUCF													
CO_2	-3493	-3840	-3319	-4124	-3798	-4651	-4238	-4201	-3835	-4681	-3386	-5568	-5704
CH_4	48	24	72	64	57	34	19	39	118	9	159	21	3
N_2O	5	2	7	7	6	3	2	4	12	1	16	2	0
Total	-3440	-3815	-3240	-4054	-3736	-4614	-4217	-4159	-3705	-4671	-3211	-5545	-5701

The forecasts of greenhouse gas emissions evolutions that are included in the 2nd National Program for Climate Change were updated in order to comprehend the most recent data for the determination of the total quantity of allowances. It is noted that in order to forecast the evolution of greenhouse gas emissions by the energy sector was used the ENPEP (Energy and Power Evaluation Program) Software Package[31], while for the non –

[31] The Windows version of the Energy and Power Evaluation Program (ENPEP) is a set of ten integrated energy, environmental, and economic analysis tools and is the premier energy system analysis software in use in over 80 countries. The ENPEP for Windows system is developed by CEEESA with support from the U.S. Department of Energy (USDOE). Several ENPEP modules are

energy sectors the calculations were based on adapted tendency models, which calculate green house gas emissions taking into account the development of activity data, suitable emission factors and concrete assumptions per sector and by applying a calculation methodology per sector / gas, as also applied in annual greenhouse gas emission inventory.

4.2. Main Assumptions in the BaU Scenario

Below, we present the basic assumptions that were made for the formulation of the current Business as Usual (BaU) Scenario of greenhouse gas emissions in Greece for the period up to 2020.

Demographic characteristics: According to the population census conducted by the National Statistical Service in 2001, the population of Greece increased with an average annual rate of 0.67% during the period 1991-2001, while the average annual population growth rate during the period 1991 – 2020 is estimated to be approximately 0.4%. Because of the ageing of population, during the period 2000-2020, the average household size is estimated to decrease by approximately 0.8% annually.

Climatic conditions: Future climatic conditions have been assumed to remain the same as those during the period 1995-2000. Assuming that the weather conditions will be closer

developed by and are the property of the International Atomic Energy Agency (IAEA). These are non-commercial modules that can be obtained under separate IAEA release agreements.

ENPEP allows users to evaluate the entire energy system (supply and demand side), perform a detailed analysis of the electric power system, and evaluate environmental implications of different energy strategies. Each module has automated linkages to other ENPEP modules as well as stand-alone capabilities. The newest ENPEP version (ENPEP for Windows) takes full advantage of the Windows operating environment.

to the historical average temperature would lead to a sudden, non-justifiable increase of space heating requirements after the year 2000 while it would probably underestimate the energy demand for air conditioning.

Table 4.2: Main assumptions in the BaU scenario

	Historic Data			Projections			
	1990	**1995**	**2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Population (mio.)	10.2	10.5	10.9	0.6%	0.4%	0.3%	0.2%
Household size (cap/hh)	3.2	3.1	3.0	-0.7%	-0.8%	-0.8%	-0.8%
GDP (bil. € 1995)	75.1	79.9	94.6	3.9%	3.4%	3.0%	2.9%
Gross value added (bil. € 1995)							
Primary sector	6.08	7.28	7.30	2.0%		0.7%	
Industry	15.3	14.8	17.0	2.7%		1.8%	
Public Services	14.9	15.6	17.2	2.3%		1.85	
Private Services	31.3	34.5	43.2	5.0%		4.0%	
International Fuel Prices							
Coal ($2000/t)	63.1	50.0	35.1	38.4			
Oil ($2000/bbl)	27.3	21.2	28.1	-4.8%	0.0%	1.8%	1.7%
Natural Gas	146.6	113.8	110.9	-4.8%	0.0%	1.8%	1.75
Transport Activity							
Passenger Transport (bil.p-km)	84	101	118	3.2%	3.0%	2.7%	2.3%
Goods Transport (bil. t-km)	18	23	26	3.1%	2.9%	2.4%	2.1%

Macroeconomic sizes: It is assumed that the program of convergence of Greek economy with the average European Levels will continue throughout the period examined. As a result Greek economy success higher rates of development compared to the community average. In particular, it is assumed that the GDP will increase during the period 2000-2006 with an average annual increase rate of about 3.8%, while during the period 2006-2010 this rate is reduced to 3.4%. The expected annual financial growth rate for the period following 2010 is 3%. Table 2 specifies the assumptions regarding the development per sector.

Prices / Taxation of fuels: Not only does the level of energy prices influences the future total demand of the energy system, but it also affects the shares of various energy resources / technologies in order to cover this demand and the total emissions

from the energy sector. Table 4.2 presents the fluctuations of international prices of fuels that were adopted in the frame of this study. The projection of fuel depends on the conditions that prevail in the international oil, natural gas and coal markets. In addition it was assumed that basic characteristics of the existing tax policy for fuels will not be altered and a carbon tax will not be imposed on fuel prices during the period under consideration.[32]

It is notable that the elasticity of energy demand in various sectors of consumption of the Greek energy system with regard to international prices of oil/natural gas is low. Thus, on one hand, it is expected only small differentiation in total greenhouse gas emissions by important short – term fluctuations in the prices of fuels. On the other hand, total greenhouse gas emissions are altered significantly when price fluctuations lead to changes of the relative economic attractiveness between oil / natural gas and solid fuels consumption.

Discount rate: The choice of the appropriate discount rate is a fundamental problem in economic theory. In general, according to IPCC (1996), there are two approaches to discounting: "An ethical approach based on what rates of discount should be applied and a descriptive approach based on what rates of discount people actually apply in their day-to-day decisions".[33] The first is reflected to low rates of discount (around 3 percent in real

[32] The presented assumptions are not significantly different from the ones adopted in the European Commission study on the development of energy systems in most European countries.
[33] Halsuœ, K., Painuly, J.P., Turkson, J., Meyer, H.J., Markandya, A. *Economics of Greenhouse Gas Limitations,* UNEP, Collaborating Center on Energy and Environment, Denmark, 1999, pp.20

terms[34]) and the second to higher rates (in some cases very high rates of 20 percent and above). The discount rate allows the comparison between near-term costs and benefits that occur in the future. In economic analyses of long term Greenhouse Gas policy programmes or projects the choice of future as more important than the present is revealed by lowering the social rate of discount[35]. In contrast, if the discount rate applied is relatively high, the economic welfare of future generations may be adversely affected. However, projects with uncertain benefits are preferred to be discounted more highly on the ground of risk aversion. Thus, the Greek NAP adopts the descriptive method of discounting in order to take into account the profile of each decision-maker. In detail, it assumes that as consumers in domestic sector usually prefer investments with small payback period, it adopts a discount rate of 14%. On the other hand, the industries, utility companies, refineries, etc, prefer long-term investment policies so that discount rate of 6% considered more suitable. Finally, a medium rate of discount of 9% was adopted for the tertiary sector as it is considered that in this sector are vitalized smaller size enterprises.

Industrial processes: the prediction of emissions from this sector is based on:

- The analysis of statistical data of sectors activity
- The use of emission factors that were presented during the last national greenhouse gas emissions/ removals inventory. It has not in the BaU scenario the possibility of technological improvements for the next five years. Table 3 presents the specific assumptions per sector.

[34] The real rate of discount is the market rate net of inflation. For instance, if a market has a discount rate of 12% and inflation is 8% then the real rate is 4%.
[35] The "best" rate is often called the social rate of discount" or the "correct" rate (OECD 1983 pp.20-1)

Table 4.3: Main assumptions for the BaU scenario in Industrial Processes[36]

Cement Production	Clinker production changes with a mean annual rate of 0.4% for the period 2000-2020, while the exploitation of plants capacity remains high
Lime Production	Limestone consumption changes with a mean annual rate of 1.5% for the period 2000-2020
Glass Production	Glass production changes with a mean annual rate of 1.8 % for the period 2000-2020
Use of Carbonic Calcium	Limestone consumption for aluminum, iron and steel, and ceramic production changes with a mean annual rate 1.7% for the period 2000-2020
Iron – Steel	Steel production changes with a mean annual rate of 4.6 % for the period 2000-2020, due to the investments realized after 2000
Aluminum Production	Aluminum production remains at 2000-2003 levels
Chemical Industry	HCFC – 22 production remains constant, while the ammonia and nitric acid production decreases significantly
F – gases Consumption	The apparent consumption of cars air-conditioners and domestic refrigerators increase annually the 2.5 % for the period 2000-2020, while the apparent consumption of air – conditioning units increase with an average annual rate of 4.5%.

Agriculture: the development trends during the last decade were evaluated in order to forecast the development of the size of agriculture area, the livestock population and the use of nitrogen fertilizers. According the evaluation is predicted a small reduction of agricultural area size with simultaneous improvement of production index, a small increase of livestock population, and a remarkable reduction of synthetic nitrogen fertilizers use.

Waste: Prediction of emissions by the waste sector was based on:

a. Population growth.

[36] In the annual GHG Emissions Inventory, emissions from ferroalloys production are included in the Energy Sector.

b. Daily waste production by type of geographical area by the assumption that it follows the last decades trend for each area.

c. The implementation of Directive 1999/31/EC of the European Council for the landfill of waste.[37]

4.3. Prediction of development of the energy system

In order to frame the Nap was used the energy model ENPEP. ENPEP was developed by Argonne National Laboratory and contains a set of Analytical tools for use in integrated energy/electricity system planning and the quantification of environmental burdens. In particular, ENPEP uses a non-linear, equilibrium approach to determine the energy supply demand balance. The equilibrium modeling approach used in the BALANCE Model is based on the concept that the energy sector consists of autonomous energy producers and consumers that carry out production and consumption activities, each optimizing individual objectives. A fundamental assumption of the model is that producers and consumers both respond to changes in price. Furthermore, energy demand is sensitive to the prices of alternative, as supply price is sensitive to the quantity demanded. ENPEP seeks to find, besides the intersection of the supply and demand curves, the intersection for all energy supply forms and all energy uses that are included in the energy network. The equilibrium is reached when the model finds a set of prices and quantities that satisfy all relevant equations and restrictions.

So, according to the results of energy model ENPEP, the total primary energy demand in Greece is expected to continuously increase in the long run (from 23.9 Mtoe in 1995

[37] Greece can use a 4-year grace period in achieving the objectives of the Directive for biodegradable waste, which result in the quantitive objectives of the Directive being achieved in the years 2010, 2013 and 2020, instead of 2006, 2009 and 2016 that is determined for general cases of application of the Directive.

to 34.9 Mtoe in 2010 and to 41.4 Mtoe in 2020), with an average annual increase rate of around 2.2%. In table 4 is given a brief presentation on the development of the gross inland consumption of the country for the period 1995-2020.

Table 4.4: Gross inland consumption in Greece

	Gross Inland consumption in Greece (in ktoe)						Annual Average Change (%)		
	1995	**2000**	**2005**	**2010**	**2015**	**2020**	**95/00**	**00/10**	**10/20**
Solid fuels	8374	9131	9260	9336	9383	9533	1.7%	0.2%	0.2%
Liquid fuels	14238	16192	17405	18940	20327	21950	2.6%	1.6%	1.5%
Renewables	1152	1299	1413	1502	1556	1722	2.4%	1.5%	1.4%
Natural Gas	58	1710	3028	5094	6622	8096	96.7 %	11.5%	4.7%
Electricity	69	-1	150	-1	100	100	-141.5 %	-1.9%	
Total	***23891***	***28331***	***31256***	***34871***	***37990***	***41402***	***3.5%***	***2.1%***	***1.7%***
Energy Intensity (ktoe/mio. Euro 1995)	0.30	0.30	0.27	0.26	0.24	0.23	0.0%	-1.5%	-1.2%
Gross Inland Consumption per capita (toe/cap)	2.27	2.61	2.79	3.05	3.27	3.52	2.8%	1.6%	1.5%

According to the above results, gross inland consumption in Greece increases continuously during the entire time period (from 23.9 Mtoe in 1995 to 34.9 Mtoe in 2010 and to 41.4 Mtoe in 2020), with an average rate of growth around 2.2%. *Liquid fuels* still cover the major part of gross inland consumption, but their contribution decreases from 56.9% in 1995 to 54.3% in 2010 and to 53% in 2020. *Solid fuels* consumption presents an increase in the order of 14% during the period 1995-2020, while their share falls from 35.1% in 1995 (approximately 8.4 Mtoe) to 23% in 2020 (approximately 9.5 Mtoe). It is also projected that *natural gas* covers a significant part of the gross inland consumption, which is estimated at 14.6 5 in 2010 and at 19.6% in 2020, thus resulting in a decrease of the relative contribution of solid and liquid fuels.

The contribution of RES including large hydro in gross inland consumption for the entire period examined declines from 4.8% in 1995 (1.15 Mtoe) to 4.3% in 2010 (1.5 Mtoe) and to 4.2 % in 2020 (1.72 Mtoe). In absolute values, RES exploitation increases by 49.5% from 1995 to 2020.

Electricity demand is expected to expand with an average annual rate of 3% during the period 2000-2010, while this rate declines to 2.5 % during the following decade. Thus, total installed power generation capacity in Greece increases by some 9.2 GW in the period 1995-2020. However, the use of traditional lignite and oil power does not change significantly during the study period the increased capacity needs are mainly covered. The increased capacity needs are mainly covered with the installation of natural gas combined cycle power plants. This technology provides significant economic and technical advantages so it is foreseen that the total installed capacity of units of this category increases roughly 5 times during the period 2000-2020, to reach 5.8 GW or around 31.2% of the total installed capacity by 2020. In addition it is expected that the installed generation units using RES to increase significantly. At the same time, the installed capacity of large hydro units remains practically the same during the reference period, while 1.6 GW of wind farms are expected to be installed until 2020, as a result of the rich wind potential in Greece and the support policies implemented by the Greek government.

Final energy consumption increases continuously during the entire time period (from 16.1 Mtoe in 1995 to 24.8 Mtoe in 2010 and to 29.7 Mtoe in 2020), with an average rate of growth in order of 2.5%. Liquid fuels have the highest share in final energy consumption, presenting however a slight decrease of their contribution from 69.6% in 1995 to 65.3% in 2010 and to 62.8% in 2020. Additionally, electricity contribution to final energy consumption increase from 19% in 1995 (3.1 Mtoe) to 20.9% in 2010

(5.2Mtoe) and to 22.3% in 2020(6.6Mtoe). Natural gas represents approximately 6.5% of final energy consumption in 2010 (1.6 Mtoe), while this percentage increases to 7.9% in 2020 (2.4 Mtoe). The share of RES declines from 5.1% in 1995 to 3.4% in 2010 and to 3.2% in 2020. The reduction of share of RES in final energy consumption is mainly due to reduction of biomass consumption in the domestic sector. Table 4.5 presents the final consumption of energy in Greece for the period of study.

Table 4.5: Evolution of final energy consumption per fuel in Greece (in ktoe)

	1995	2000	2005	2010	2015	2020
Solid fuels	**972**	**818**	**810**	**768**	**777**	**816**
Liquid fuels	**11225**	**13711**	**14962**	**16197**	**17347**	**18655**
Electricity	**3063**	**3840**	**4498**	**5178**	**5881**	**6614**
Thermal energy	**0**	**55**	**87**	**199**	**316**	**331**
Renewables	**825**	**909**	**871**	**855**	**867**	**936**
Natural Gas	**43**	**349**	**982**	**1603**	**2067**	**2356**
Total	**16128**	**19682**	**22210**	**24799**	**27254**	**29707**

4.4. Results of emissions projections

Tables 4.6 and 4.7 present the overall outcome of greenhouse gas emissions projections for the period 2000-2020. It should be highlighted that emissions/removals by the Land Use Change and Forestry sector have not been taken into account of the calculation of base year emissions, because in 1990 this sector was a “net” sink for greenhouse gas emissions. Furthermore, according to the protocol is not included this sectors contribution in national totals for two more reasons. Firstly, emissions/removals by anthropogenic activities that (a) cause land use changes due to forestation, reforestation or deforestation (b) took place after 1990 and (c) have been calculated with verifiable methodologies (Article 3, Paragraph 3) should be included. However, the data available for land use in Greece do not allow the forecast of relative emissions/removals for the time being. Secondly, a contracting Party that belongs in the Annex I of the convention and has ratified the Protocol, has the possibility, provided that it makes a decision, to include emissions/removals by activities undertaken after 1990, involving revegatation and forest management, cropland management and grazing land management. Since there is no relative decision and the available data are not sufficient, no forecast regarding this matter has been made in the frame of the present project.

So, BaU scenario foresees that greenhouse gas emissions in 2010 (153.5 Mt CO_2 eq) will increase by 39.2% compared to base year emissions (110.2 Mt CO_2 eq), while in 2020 (173.7 Mt CO_2 eq) the corresponding increase rate is estimated to be 57.6%. Thus, taking the above into consideration, it is expected a significant increase of greenhouse gas emissions in Greece. Since the national target is to limit the increase of emissions during the period 2008-2012 to 25% of base year emissions rises a gap between the target and the BaU scenario. In accordance with criterion 1 of Annex II of the Directive 2003/87, the aforementioned projections are taken into consideration for the formulation of the Nap.

Table 4.6: Projections of GHG emissions in the BaU scenario, disaggregated by sector (in kt CO_2 eq)

Sources/sinks	1990	1995	2000	2005	2010	2015	2020
Energy	**80996**	**84622**	**101636**	**111041**	**121671**	**129909**	**139253**
Industrial processes	**9140**	**11520**	**12879**	**14171**	**16414**	**18998**	**21299**
Solvent and other product use	**170**	**153**	**145**	**158**	**161**	**164**	**166**
Agriculture	**13603**	**12573**	**12425**	**11969**	**11592**	**11227**	**10872**

Land – Use Change and Forestry	**-3440**	**-4614**	**-3211**	**-4942**	**-4992**	**-4706**	**-4440**
Waste	**4044**	**4651**	**4617**	**5265**	**3612**	**2500**	**2103**
Total (without LUCF)	**107953**	**113520**	**131702**	**142604**	**153450**	**162798**	**173693**
Total (with LUCF)	**104513**	**108906**	**128491**	**137662**	**148458**	**158092**	**169253**

Table 4.7: Projections of GHG emissions in the BaU scenario, disaggregated by gas (in kt CO_2 eq)

Gas	Base year	1990	1995	2000	2005	2010	2015	2020
CO2	83905	83905	87497	104072	114107	124269	132200	141176
CH4	8715	8715	9418	9644	10338	9013	8117	7935
N2O	14140	14140	13152	13564	13050	12924	12768	12652
HFCs	3369	935	3369	4272	5022	7158	9626	11842
PFCs	83	258	83	148	88	88	88	88
SF6	NE	NE	NE	NE	NE	NE	NE	NE
Total	**110212**	**107953**	**113520**	**131702**	**142604**	**153450**	**162798**	**173693**
Change from Base Year	100	98	103	119	129	139	148	158
Land – Use Changes and Forestry		-3440	-4614	-3211	-4942	-4992	-4706	-4440
CO2		-3493	-4651	-3386	-4994	-5044	-4759	-4492
CH4		48	34	159	48	48	48	48
N2O		5	3	16	5	5	5	5

Figure 4.1 shows the path to reach the Kyoto target in 2010.

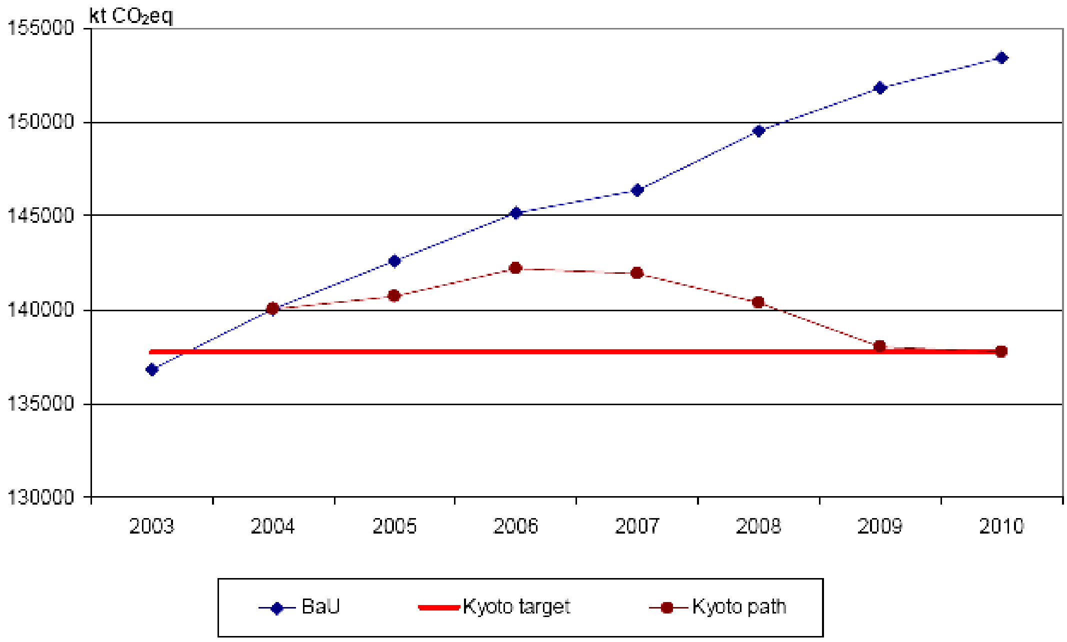


Figure 4.1: Evolution of GHG Emissions in Greece according to the BaU scenario and the Kyoto path up to the year 2010.

So, according to this path, greenhouse gas emissions in the country during the three-year period 2005-2007 should decrease compared to the revised BaU by 2.1% in total, with required reductions compared to the BaU of 1.9 Mt CO_2 eq in 2005, 3 Mt CO_2 eq in 2006 and 4.4 Mt CO_2 eq in 2007. The total emission allowances to be allocated for the triennium 2005-2007 were estimated to be 223.266.053 t CO_2. Total allowances were estimated on the basis of the most recent available data with respect to the share of emissions from covered installations to total GHG emissions of the country and for the estimation the "forecasting" approach was followed. These allowances will be allocated for free (which means that for the period 2005-2007 there is no intention of auctioning allowances). In point of the unused of the reserve for new entrants through 31 December 2007, these are expected to be auctioned from competent authority by the 15th of February 2008 at least.

4.5. Determination of the total quantity of emission allowances for the period 2005 to 2007 – Results

Directive 2003/87/EC establishes the scheme for greenhouse gas emissions allowance trading in order the European community and member states to reach their Kyoto target. Moreover, according to Criteria I of Annex III of the Directive 2003/87/EC, the total quantity of allowances to be allocated to covered installations shall be consistent with the Member State's target according to Kyoto Protocol. However, as figure 10 reveals, during the first commitment period there is no quantitative target to be met and the "path" to the Kyoto target following increasing during 2005-2007.

At this stage of analysis, the development of the National Allocation Plan requires the appropriate information for each installation covered by the Directive, as it is necessary the calculation of greenhouse gas emissions.[38] Table 8 presents the total projected CO2 emissions of installations covered by the emissions trading Directive, in relation to the total projected greenhouse gas emissions and the annual allowances for the period 2005-2007.

Table 4.8: Projected CO2 emissions from the installations under Directive 2003/87 in reduction to total GHG emissions in Greece according to the BaU scenario (in kt CO_2eq)

Year	2005	2006	2007	2008	2009	2010	2011	2012
CO2 EMISSIONS FROM COMBUSTION ACTIVITIES								
Electricity Generation	54,580	55,891	56,109	57,169	58,255	58,917	59,483	59,757
Other Combustion Plants	1,207	1,224	1,241	1,258	1,276	1,293	1,311	1,330
Refineries	2,937	2,929	2,921	2,914	2,907	2,901	2,892	2,883
Sintering	100	100	100	100	101	101	101	101
Iron and Steel	176	185	190	190	190	190	191	191
Cement Production	4,407	4,409	4,412	4,417	4,423	4,426	4,430	4,435
Lime Production	241	243	246	249	252	256	259	262
Glass Production	84	84	84	84	84	85	85	85

[38] Only CO_2 for the period 2005-2007

Ceramic Production	592	593	594	596	597	599	600	601
Paper Production	213	213	212	215	218	221	224	227
Total	64,537	65,870	66,110	67,193	68,303	68,989	69,575	69,872
CO2 EMISSIONS FROM INDUSTRIAL PROCESSES								
Electricity Generation	152	152	152	152	152	152	152	152
Other Combustion Plants	0	0	0	0	0	0	0	0
Refineries	972	1,307	1,307	1,307	1,307	1,307	1,307	1,307
Sintering	714	715	715	716	716	717	717	718
Iron and Steel	602	632	647	648	649	649	650	651
Cement Production	6,958	6,962	6,967	6,975	6,984	6,989	6,995	7,004
Lime Production	601	608	615	622	630	639	647	655
Glass Production	27	27	27	27	27	27	28	28
Ceramic Production	229	231	233	235	237	238	240	241
Paper Production	0	0	0	0	0	0	0	0
Total	10,256	10,633	10,664	10,682	10,702	10,718	10,735	10,754
TOTAL CO_2 EMISSIONS								
Electricity Generation	54,732	56,043	56,261	57,321	58,406	59,069	59,635	59,909
Other Combustion Plants	1,207	1,224	1,241	1,258	1,276	1,293	1,311	1,330
Refineries	3,909	4,235	4,228	4,221	4,214	4,208	4,199	4,190
Sintering	815	815	816	816	817	818	818	819
Iron and Steel	778	817	837	838	839	840	841	841
Cement Production	11,365	11,370	11,379	11,392	11,407	11,415	11,425	11,439
Lime Production	842	851	861	872	883	894	905	917
Glass Production	111	111	111	111	112	112	112	113
Ceramic Production	821	824	827	830	833	837	840	842
Paper Production	213	213	212	215	218	221	224	227
Total	**74,793**	**76,503**	**76,774**	**77,875**	**79,006**	**79,707**	**80,311**	**80,626**
Total National GHG Emissions	**142,604**	**145,137**	**146,336**	**149,549**	**151,808**	**153,451**	**155,121**	**156,433**
Contribution of ETS Units	**52.4%**	**52.7%**	**52.5%**	**52.1%**	**52.1%**	**51.9%**	**51.8%**	**51.6%**

The allocation of emissions allowances is conducted in two stages, first at activity level and then at installation level:

- At activity level the allocation of emission allowances is based on the following principles:

1. Initially, the total quantity of emission allowances does not include the quantity of emission allowances for the reserve of the known new entrants.[39]
2. The emissions reduction of CO_2 from process, as it requires essential modifications on productive process, it is expected to be rather difficult technically and economically to be implemented in those activities in which the great majority of installations consist of small and old fashioned facilities. Thus, the basic principle for the allocation of emission allowances at activity level for the period 2005-2007 refers to *the non-requirement for reduction of the projected emissions of CO_2 from processes*[40].
3. It is adopted *the non- requirement for reduction of the CO2 emissions from the existing co-generation units* because it is important to promote and support the co-generation as it replaces the production of electricity.
4. The emission allowances for the remaining foreseeable activities should be equal to the quantity of the remaining emission allowances after the subtraction of the aforementioned quantities.
5. The quantity of the emission allowances of the reserve of the unknown new entrants was determined based on the most recent year available data and as a percentage of CO_2 in 4 specific activities with possibility to have new entrants.

Thus, the basic calculation equation is:

[39] The known new entrants include the electricity generation installations, the co-generation installations, the extensions of the already existing refineries, and the extension of the Halvourgiki installation.

[40] The next trading period (2008-2012) as it is much more demanding in terms of emission reduction according to the Kyoto Path, it is necessary to begin effectively promoting the implementation of the Best Available Techniques (BAT) in the Greek industry, in order to reduce, among other things, the emissions of CO_2.

$$TA = A_{auction} + A_{KNER} + Cf_p \cdot \sum_{i=1}^{10} \left(\overline{EP_i} \cdot GrP_i \right) + Cf_c \cdot \sum_{i=1}^{10} \left(\overline{EC_i} \cdot GrC_i - \overline{CHP_i} \cdot 3 \right) + \overline{CHP_i} \cdot 3 \quad (4.1)$$

Where:

TA : *total quantity of emission allowances for the period 2005-2007*

$A_{auction}$ *quantity of emission allowances auctioned for the period 2005-2007*

A_{KNER} *emission allowances of known new entrants reserve for the period 2005-2007*

Cf_p *compliance factor for emissions of CO2 from processes (=1)*

Cf_c *compliance factor for emissions of CO2 from combustion*

$\overline{EP_i}$ *historic emissions from processes for activity i*

GrP_i *growth factor for process emissions for the activity i*

$\overline{EC_i}$ *historic emissions from combustion for activity i*

GrC_i *growth factor for combustion emissions for the activity i*

$\overline{CHP_i}$ *historic emissions from cogeneration for activity I*

the substraction of the quantity of the emission allowances in the reserve of unknown new entrants from the various activities is made proportionally according to:

$$SA_i^{'} = SA_i \cdot \left(1 - \frac{A_{UNER}}{\sum_i SA_i} \right) \quad (4.2)$$

where

$SA_i^{'}$ *emission allowances for the total of the existing installations of activity I for the period 2005-2007*

SA_i *emission allowances for the activity I for the period 2005-2007 prior to the substraction of the unknown new entrants reserve*

A_{UNER} *emission allowances of the reserve of the unknown new entrants for the period 2005-2007*

Table 4.9 presents the results deriving from the application of the aforementioned allocation methodology, in combination with the total quantity of emission allowances and the size of the reserves.

Table 4.9: Comparative assessment of CO2 emissions from ETS units in the BaU scenario and the allowances provided per activity

	Electricity Generation	**Refineries**	**Iron & Steel**	**Sintering**	**Cement**	**Lime**	**Glass**	**Ceramic**	**Paper**	**Other Combustion**	**Total**
BaU	**167,035,780**	**12,372,571**	**2,432,016**	**2,445,470**	**34,114,699**	**2,553,899**	**332,836**	**2,472,670**	**637,951**	**3,672,693**	**228,070,584**
TOTAL ALLOWANCES	*162,914,253*	*12,189,422*	*2,418,379*	*2,438,022*	*33,787,421*	*2,535,837*	*326,615*	*2,429,084*	*622,166*	*3,604,853*	***223,266,053***
COMPLIANCE FACTOR WITH RESPECT TO BaU	0.975	0.985	0.994	0.997	0.990	0.993	0.981	0.982	0.975	0.982	**0.979**
NEW ENTRANTS											**9,475,497**
TOTAL ALLOWANCES IN EXISTING PLANTS	156,199,372	10,296,226	2,392,650	2,421,885	33,215,274	2,503,008	316,331	2,356,754	596,454	3,492,603	**213,790,556**
OVERALL COMPLIANCE FACTOR WITH RESPECT TO HISTORIC EMISSIONS	0.944	0.948	1.027 [41]	0.993	0.987	1.000	0.953	0.946	0.922	0.991	**0.969**
OVERALL COMPLIANCE FACTOR WITH RESPECT TO 2003 EMISSIONS	0.995	0.954	1.463 [1]	0.974	1.041	1.012	1.044	0.954	0.992	1.080	**1.004**
GAP= BaU-TOTAL ALLOWANCES	4,121,3	183,149	13,637	7,448	327,278	18,062	6,221	43,586	15,785	67,84	**4,804,531**

The table includes the **gap** between projected CO2 emissions from the installations under Directive 2003/87 and total allocated allowances for the triennium 2005-2007.

[41] The compliance factor is greater than 1 as significant investments were realized in the period 2001-2003 resulting to the considerable increase in their production levels.

Utilizing all available data and information from sectoral institutions, relevant studies/inventories that took place recently under the scope of environmental Directives, or other relevant projects, 141 installations[42] were found to be in compliance with the requirements of Annex I to the Directive.

It is important to notice some crucial rules for allocation of allowances:

- **Early action**

  Early action is considered indirectly in the method of allocation at activity and installation level. In particular, in the calculation of the historical emissions at installation level the average emissions of the years of the selected baseline is used, with the exception of the year with the lowest emissions.

- **Emissions from processes**

  In the adopted method of allowance allocation is important parameter the level of difficulty to reduce CO2 emissions from processes. So it is used a compliance factor equal to 1 for all process emissions for the period 2005-2007[43].

- **Co-generation**

  Co-generation emissions are supported in the same way as emissions from process (so it is used a compliance factor equal to 1 at this case too).

- **Increase of emissions due to legislative requirements**

[42] Appendix 4 presents a full list of installations
[43]It is expected that this will change in the next trading period and the installations will adopt Best Available Techniques.

In the framework of the allocation methodology, due to legislative requirements, as Directive 2003/17/EC[44], was estimated the inevitable increase of CO_2.

- **Transferring of allowances between allocation periods (banking)**

The NAP does not permit transferring allowances between the first (2005-2007) and the sercond period (2008-2012), while it is permitted to transfer allowances within the same period (intra0period banking). Moreover, the unused allowances of any reserves, they will be sold (possibly through auction) at the beginning of 2008, while those left will be cancelled.

The U.S.A experience with limits on banking has shown that such limits complicated or hindered the operation at cap-and-trade programs and failed to provide apparent benefits.

- **Unilateral inclusion of additional installations (opt-in)**

For the period 2005-2007 is not suggested the submission of emission allowances to installations with activities listed in Annex I of the Directive 2003/87 but capacity below the limits referred to in that Annex.

- **Temporary exclusion of certain installations (opt-out)**

This possibility is not allowed for the period 2005-2007

- **Pooling**

The NAP allows the application from installations that carry out the same activity to form a pool for the period 2005-2007. However, until now the central administration has not received any relevant application.

[44] This Directive demands that the oil refineries produce “sulfur-free» gasoline and diesel.

5.Questionnaire

In order to design future scenarios for the European Emissions Trading Scheme it has been prepared a questionnaire. The aims of the questionnaire are:

- To investigate the position of Major Greek players on the National allocation Plan.
- To derive information on their future plans to be in accordance with Kyoto Protocol Mechanisms.
- To present the certain and future trends of the application of alternative policies for achieving Kyoto target.

The selected sample[45] is covered by all sectors. The questionnaire contains seventeen questions and is intended to be answered in 10-15 minutes. A printed copy of all the pages of the questionnaire can be found in Appendix 5.

5.1 Results

The answers of the questionnaire were analyzed into two levels. Firstly, they have been resolved in a quantitive way as the options rates in each question presented below Secondly, they assist us to frame the future trends in European Emissions Trading Scheme. Appendix 6 includes the full list of results.

5.1.1 Response rate

The following tables present the response rate obtained from the questionnaire in Greece and the sectors in which the responders operate.

Table 5.1: Response rate

Greek industries	**Sent**	**Received**	**Response Rate**
Total	20	10	50%

Table 5.2

Sector	***No. Companies***	***Total Allowances for the period 2005-2007 (t CO_2)***
Electricity	**0**	**156,199,372**

[45] The selected sample was from the existing installations included in the Nap for the period 2005-2007. In detail it is presented in Appendix 4.

Other Combustion	**1**	**3,492,603**
Refineries	**2**	**10,296,226**
Sintering	**1**	**2,296,226**
Iron & Steel	**1**	**2,392,650**
Cement	**2**	**33,215,274**
Lime	**0**	**2,503,008**
Glass	**0**	**316,331**
Ceramics	**2**	**2,356,754**
Paper	**1**	**596,454**
Total allowances for existing installations		**213,790,556**
Total allowances		**223,266,053**

Table 5.2 reveals that the electricity sector has the majority of total allowances. Thus, not only does electricity sector have more rights than others sectors to pollute, but it also affects intrinsic the target of Greece for achieving Kyoto target. However, it was not possible to have any response from this sector.

5.1.2 Information about the National Allocation Plan of Emissions Allowances

- In question, 1 industries were asked if they knew the Nap for Emissions Allowances and,
- In question 2, industries were asked if they participated in the configuration of NAP.

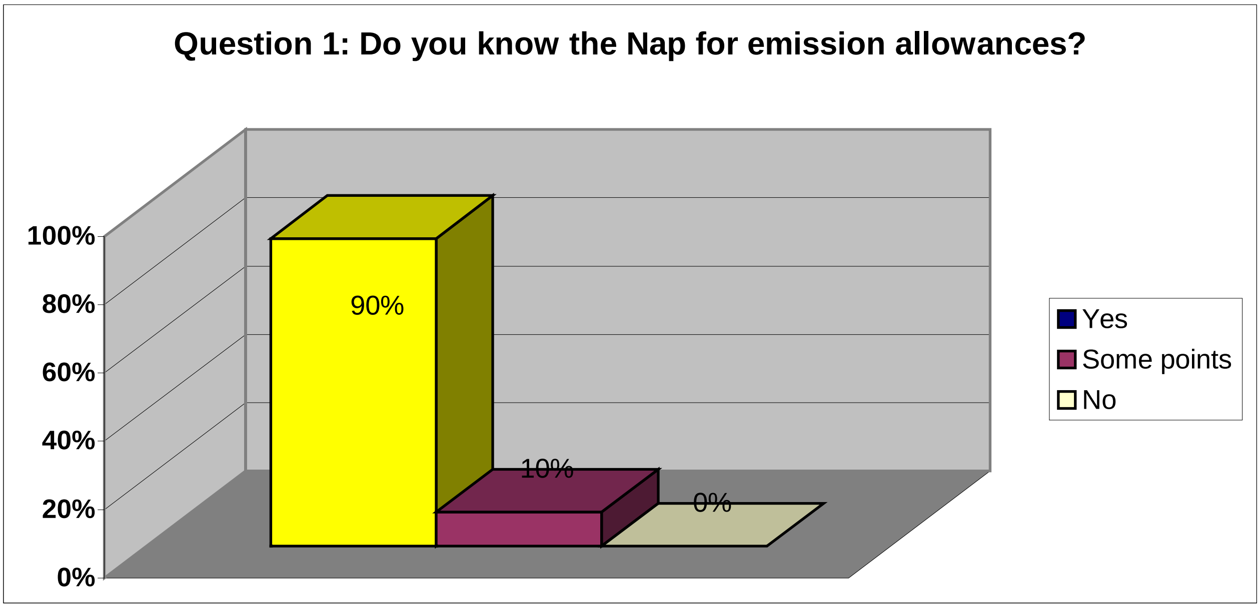


Figure 5.1

Questions 1 and 2 have the aim to derive the level of information in Greek companies, as Nap is the main mechanism of its operation, about the European Emissions Trading Scheme.

Figure 5.1 illustrates that 90 per cent of respondents are informed of Nap. However, as Figure 5.2 reveals only 50 per cent of them have participated in the configuration of Nap. It should be highlighted that 20 per cent of responders would like to have participated.

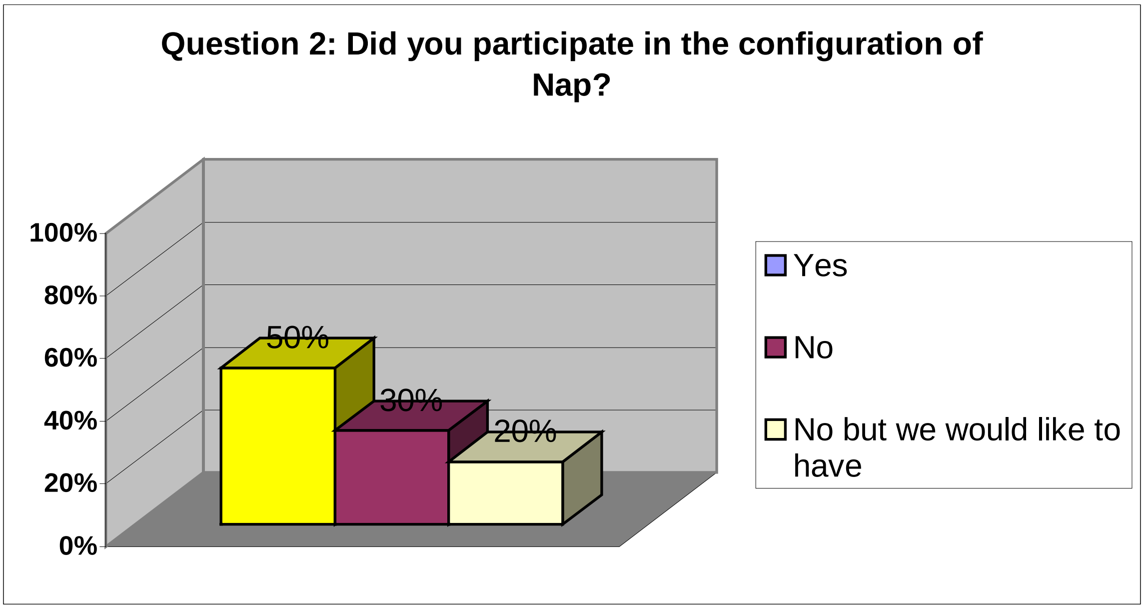


Figure 5.2

5.1.3 Impacts of National Allocation Plan of Emissions Allowances on enterprising plans

Questions 3, 4 and 5 intended to show if the Nap of Emissions Allowances covers the needs of existing installations for the period 2005-2007.

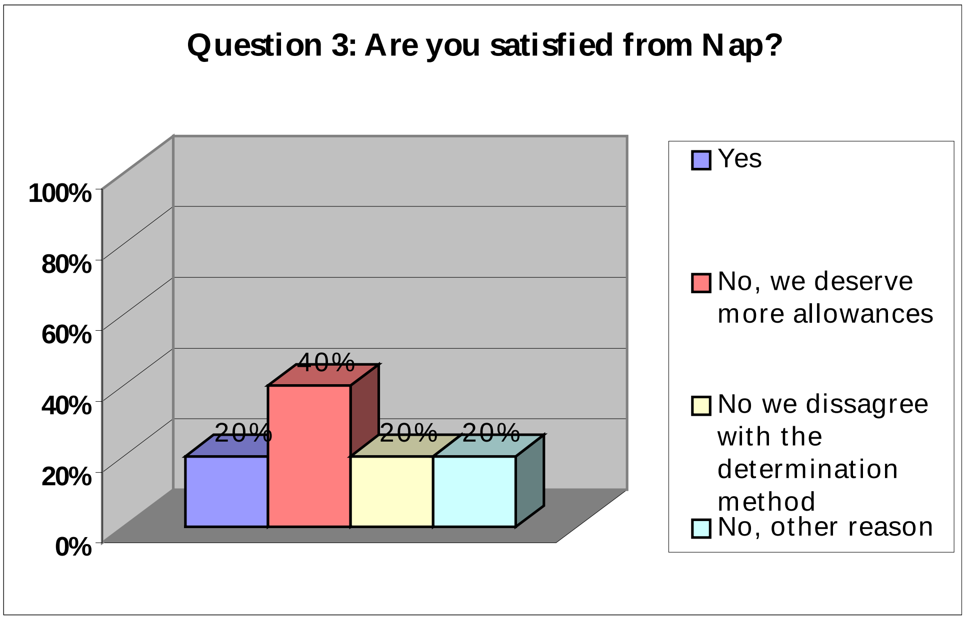


Figure 5.3

According to figure 5.3, only 20 per cent of responders are satisfied from Nap and the rest are not satisfied for three different reasons:

1. 40% believe that they deserve more allowances according to historical emissions.
2. 20% disagree with the method of determination of the share of installations covered by the Directive to the total emissions- the forecast method.
3. 20% mark other reason related to the determination method of allowances.

Figure 5.4 goes further by illustrating how companies plan to deal with their excess needs for emissions allowances. It is clearly that 70% of responders need more allowances, so:

1. 30% plan to buy allowances from free EU Trading Market
2. 10% plan to develop new productive methods via R&D
3. 30% point out other plan. In particular, the 20% purport to reduce its output.

Furthermore, question 5 examines the possibilities for the above 70% to face the need for excess allowances via alternative policies and plans. All companies indirectly agree with the statement that they haven't many economic capacities to invest in R&D.

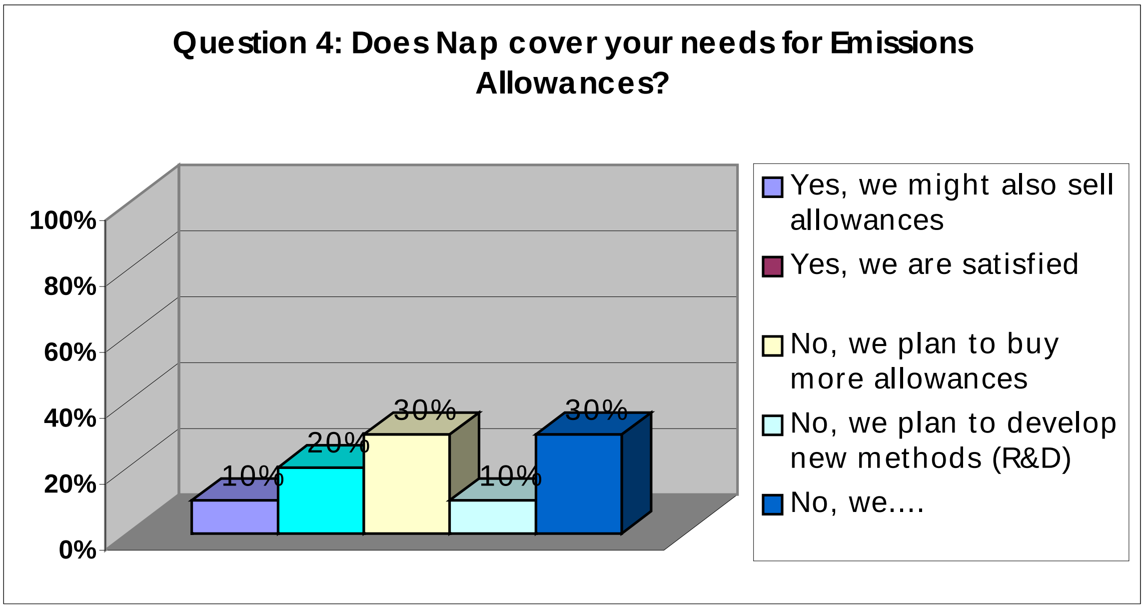


Figure 5.4

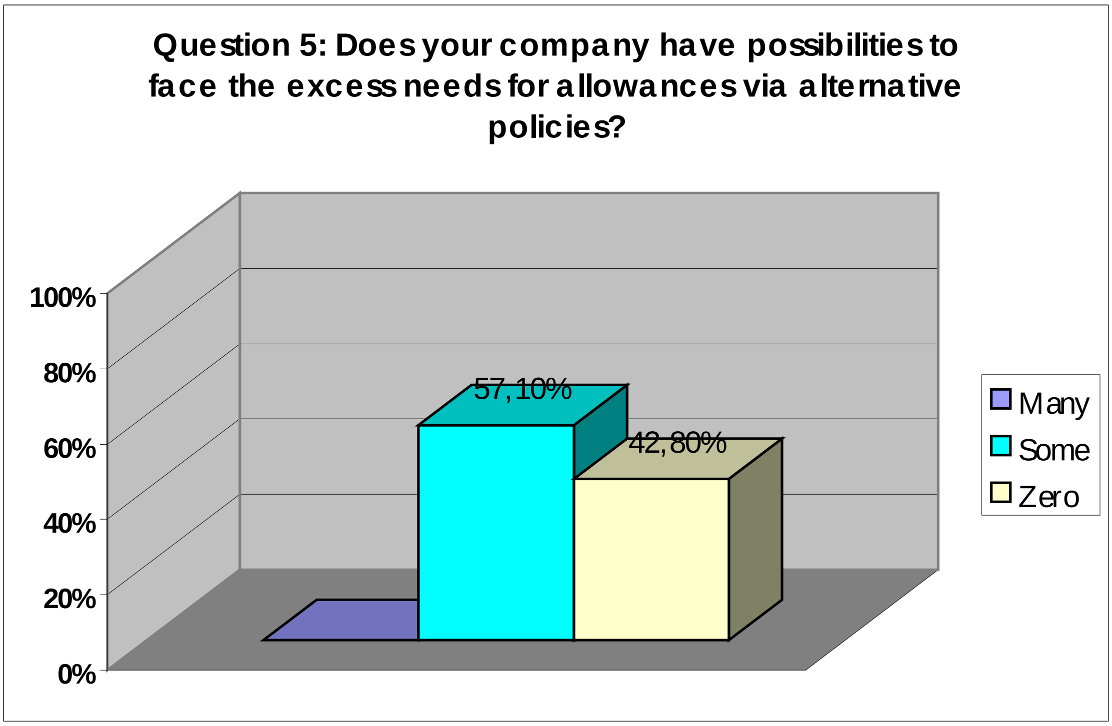


Figure 5.5

5.1.4 Greek alternatives for achieving Kyoto target

The achievement of Kyoto targets requires the adoption of alternative policies at country level. In this paper, as alternative policy is called any policy establishes environmental friendly technologies and promotes renewable energies-energy efficiency. The experience of some countries in expanding the use of renewable energy (in the electricity sector) has shown that targets can be achieved, if adequate policies are implemented. However, as it was already mentioned, the contribution of energy sector, in GHG reduction in Greece, is not substantially yet. Figure 5.6 detects that 70% of responders believe in the existence of some possibilities to achieve Kyoto target via the help of alternative policies.

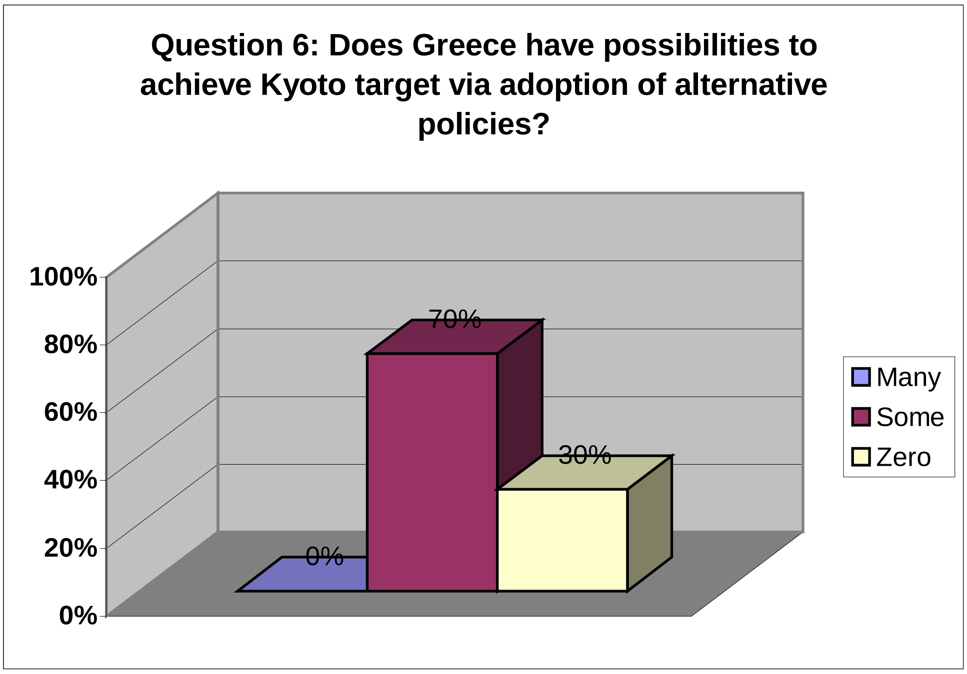


Figure 5.6

5.1.5 Information about the Carbon Market

In this part (questions 7, 8, 9) companies were asked:

- What sources of information they use to update about the carbon market,
- How efficient they consider the received information and
- They asked if they knew the current allowance price

Figure 7 shows that although the Government (local, regional and national authorities) is seen as the current main source of information, companies don't seem to be getting enough efficient data from it. It is notable that the plurality of responders (70%) informed by the scientific community. In question 8, companies were asked about the efficiency of the information. Figure 5.8 illustrates in detail their opinion.

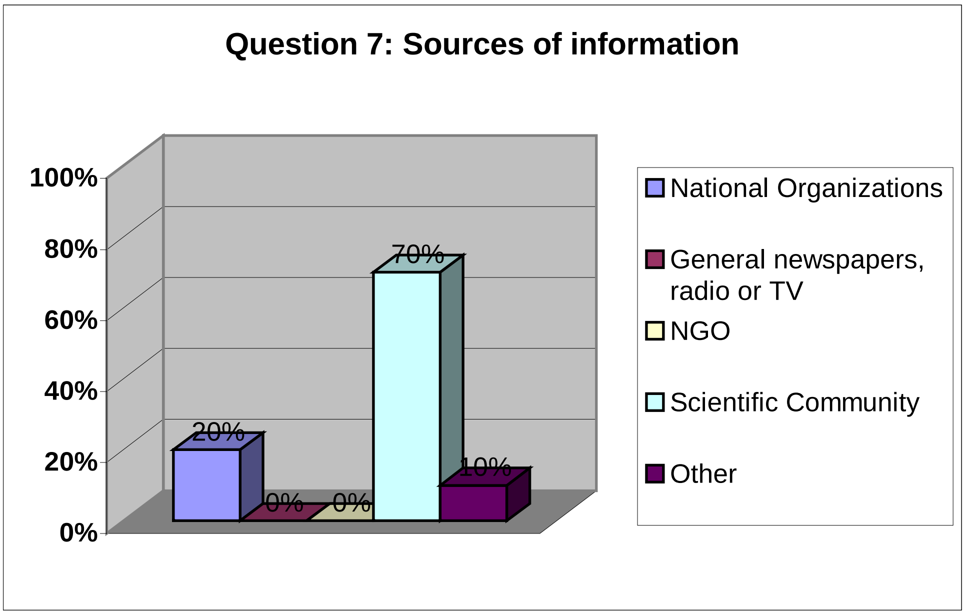


Figure 5.7

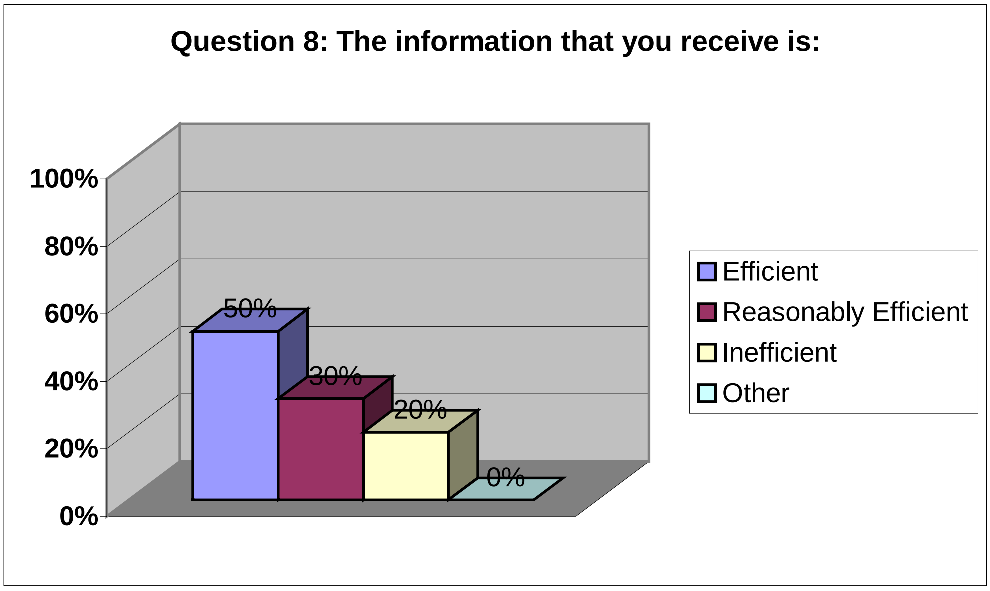


Figure 5.8

In order to examine the degree of their information sources, in question 9, they asked if they knew the present allowance price. Although 50 percent of responders reply that they know allowance price, the marked price were different from real price. So, question 9 help us to conclude that the correlation between questions 8 and 9 is small enough. The price of Carbon is influenced by numbers of key factors (policy and regulatory issues, market fundamentals, including weather and production levels, together with technical indicators).

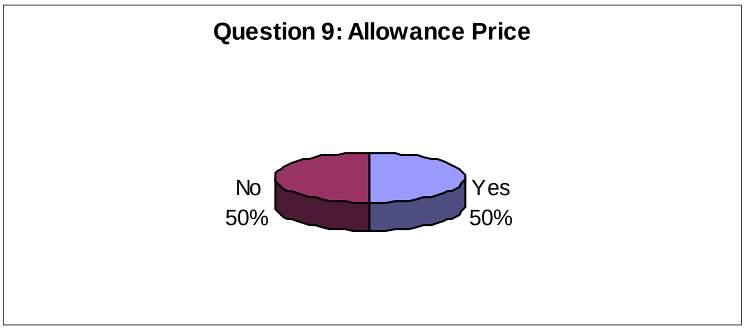


Figure 5.9

5.1.6 Expectations for Carbon Market

In this section, companies were asked:

- The price of carbon in the first period of the EU ETS from 2005 to 2007
- The main characteristics of EETS operation

As depicted in figure 5.10.1, the 40% of responders cannot make any prediction for allowance price. It is important to mention that although the 0% believes that allowance price will not be 20-30 €/ton, the current price of allowance (4/11/2005) is 21,35€. Figure 5.10.2 shows the historical prices for the period 11/10/05-08/11/05.

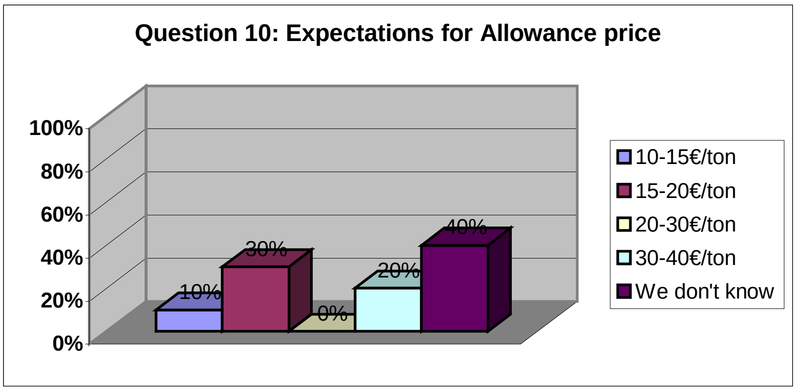


Figure 5.10.1

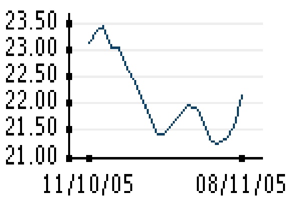


Figure 5.10.2

The key question asked by market players is "what are the factors that will determine the price of carbon in the first period of EU ETS from 20050 to 2007". The answer to this question allows a company to forecast market developments and to make investment decisions. In addition, the demand and supply of allowances define the allowance (carbon) price. The *supply* of allowances will be fixed by governments through the National Allocation Plans. Thus, the EETS is a cap and trade scheme as "governments in Member States will first determine the total quantity of allowances (the "cap") and then allocate the allowances to installations. The *demand* for allowances is in turn a function of the level of CO2 produced by the companies and installations covered by the scheme"[46]. Figure 5.11 illustrates the intuition of responders about the emerging carbon market. So, 40% expect many sellers and buyers to structure the market and 40% expect buyers to exceed sellers. None of them believe that one possibly market evolution is sellers to be more than buyers. The main perception is that the plurality EU member States, at least for the first commitment period, will ask for allowances as their Naps and additional policies cannot cover their needs to emit the environment.

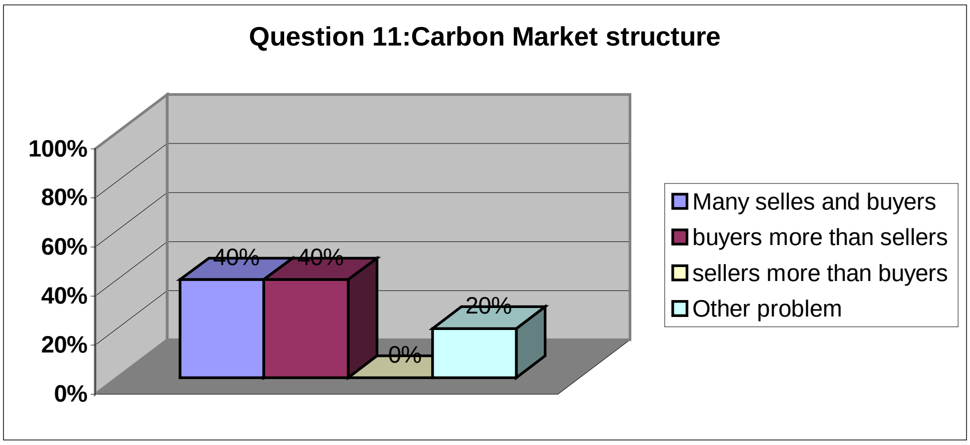


Figure 5.11

5.1.7 Additional policies

This part of questionnaire (questions 12, 13, 14 and 15) aims to examine the investments of companies for environmental friendly technologies. Figure 5.12 reveals that almost all responders are influenced by the price of petrol oil, however, 70% of them admit that do not invest in R&D for clean technologies (question 13).

[46] Point Carbon, "Carbon Market Analyst, special issue –what determines the price of carbon?", October 14-2004"

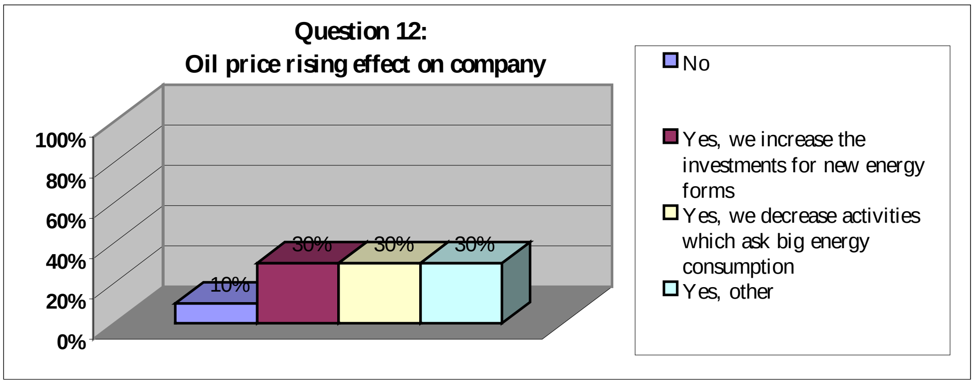


Figure 5.12

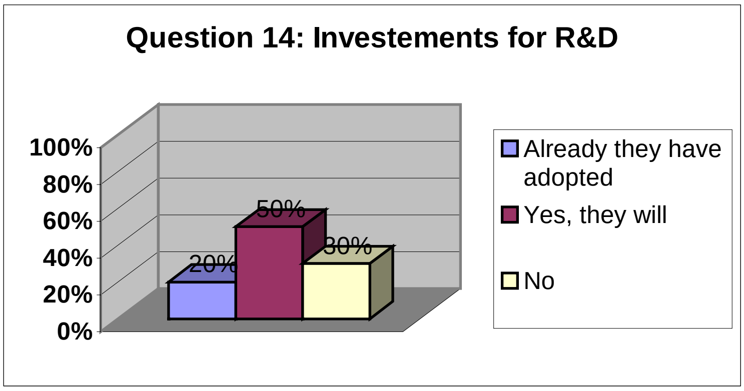


Figure 5.13

Question 15 indirectly deals with the role that Kyoto Flexible Mechanisms will play assisting corporations in reducing their costs and achieving emission targets. The 40% of responders prefer to wait and see until clearer regulations are established for both Joint Implementation (JI) and Clean Development Mechanism (CDM). From the responses, we can say that there is reluctance to participate in CDM/JI projects, since the second preferred option is not involvement in such projects. It was unexpected that two companies asked from us information about the above mechanisms, so it is evident the lack of efficient information.

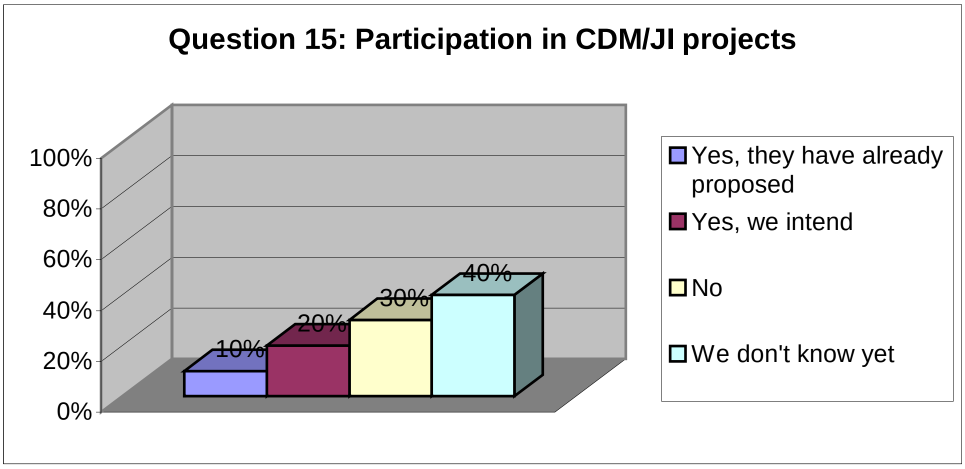


Figure 5.14

5.1.8 Additional costs from EU Emissions Trading Scheme

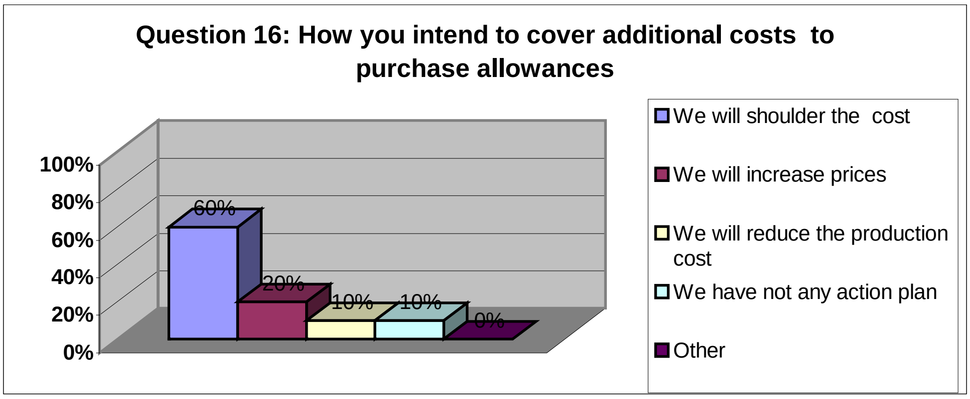


Figure 5.15

Question 16 shows the effects that the implementation of National Allocation Plan will have on the company growth and costs. In this case, companies express a clear opinion that their profits will reduce as they will shoulder the cost to purchase allowances. Moreover, 20% indicate that product prices will be increased. This result is in accordance with criterion 11 of the EU guidelines on the implementation of the NAPs which "indicates that carbon efficiency might become a competitive advantage in the long term, although in the short-term, climate commitments might imply increased costs for some companies and sectors". The point is that the Guidelines don't indicate how this will affect competitiveness of EU companies or don't propose measures to avoid negative effects.

5.1.9 Suggestions for NAP improvement

The last question can be characterized as a suggestion of how government can improve the effectiveness of NAP for the next commitment period (2008-2012). It obvious from figure 5.16 that 60% of responders inquire more incentives to invest on Renewable Energy Sources and to reduce their dependence from carbon market.

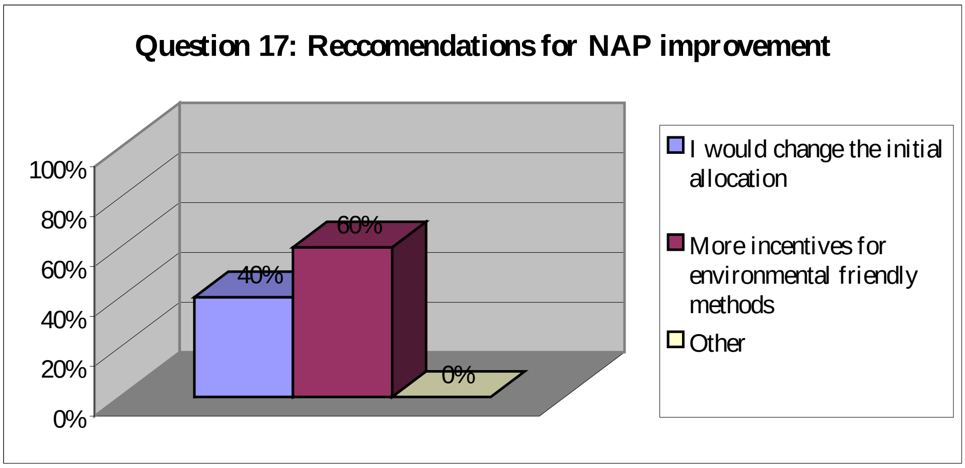


Figure 5.16

6. Future Scenarios on EETS and Greek perspectives: The B-a-u scenario

The B-a-U scenario examines the case in which arises a gap between the National aggregate demand for emissions allowances and the total allocated allowances. In particular, it is assumed that Business – as – Usual scenario prevails for 2005-2007 period. In such case, the increase of greenhouse gas emissions during the aforementioned triennium is 32,8% compared to base year emissions.

Table 6.1: The projected Gap according to B-a-U scenario For the period 2005-2007

	2005	***2006***	***2007***
Projected CO2 emissions	74,793	76,503	76,774
Annual Allowances tCO_2/y For existing installation	71,263,519	71,263,519	71,263,519
Annual Allowances tCO_2/y For New Entrants	3,158,500	3,158,500	3,158,500
Gap	370,981	2,080,981	2,351,981
Total Gap for period 2005-2007	**4,803,943 t CO_2**		

Until 2005 the environmental cost for producing GHG emissions was zero for consumers, however the European Trading Scheme establishes mechanisms that value them. So, according to the Nap of emission allowances, as table 6.1 reveals, it is projected that emission payment obligation per capita is 0.409 t CO_2[47] for the period 2005-2007. Thus, one part of emissions CO_2 is indirectly "subsidized" by the "grandfathering" emission allowances and the other part is forecasted to be purchased in free market. The question is "how the cost on permit purchase will affect the inland market".

[47] The projected emission obligation per capita is $\frac{G}{\overline{P}}$, where G (4,803,943 t CO_2): projected gap for 2005-2007 and $\overline{P}$ (11,731,084 mio): the average population for 2005-2007 according to BaU scenario.

In this analysis[48], we will focus on energy sector, which is responsible for 80,6 % of CO_2 emissions and, in particular, on the electricity generation that has the 73% of total allowances for existing installations. Figure 6.1 presents the cost of fuel per type of fuel and figure 6.2 shows the cost of kwh per type of fuel (prices 2003). From these data arises the superiority of electricity generation by lignite fuel. So, lignite is not only the major indigenous energy resource but it also provides over 70% of electricity production.

The environmental cost due to emission allowances will affect the cost of energy production. The extent of impact depends on the following factors:

1. Emission cost (allowance price)
2. The amount of extension (gap)
3. The kind of fuel

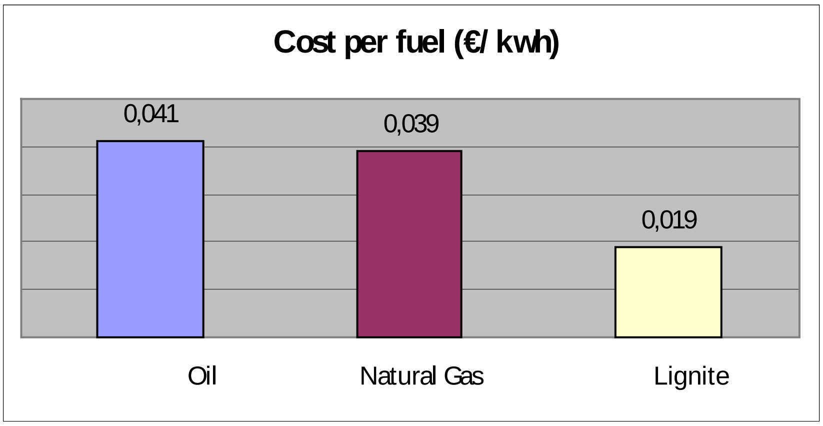


Figure 6.1

[48] The data are based on Kavouridis, K., Lignite and Natural gas in Greek electricity generation, TEE, Athens, June, 2005.

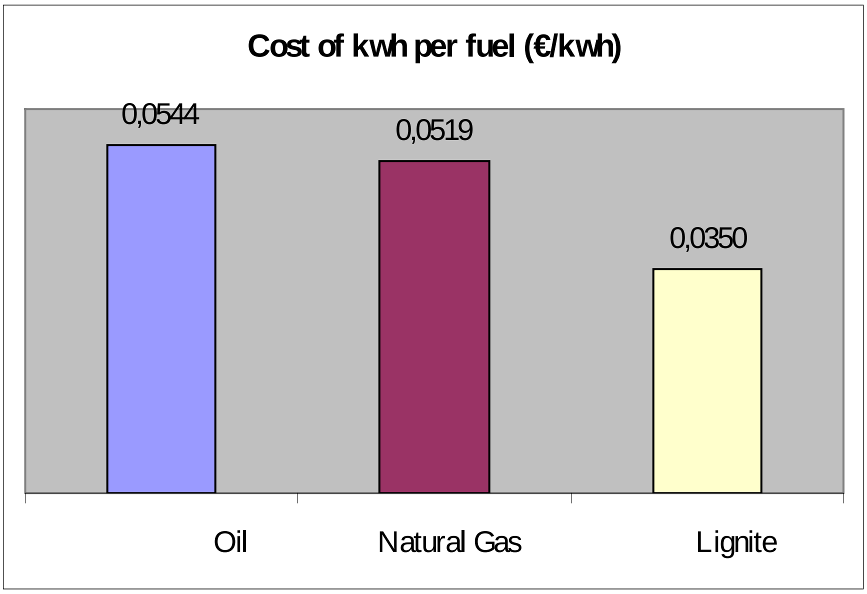


Figure 6.2

Table 6.2 presents the evolution of CO2 emissions with base year 1990 while table 6.3 the emissions coefficients per fuel.

Table 6.2: The evolution of CO2 emissions

Year	CO2 emissions (kt)- BaU	Increase rate of CO2 emissions to base year 1990 %	Weighted Emissions coefficients (kg/kwh)
1990	40776		1,3
2003	53658	31,59	1,03
2005	54732	34,22	0,97
2006	56043	37,44	0,94
2007	56261	37,97	0,92

Table 6.3: The emissions coefficients per fuel

Yea	Emissions coefficients (EC) per fuel		
	Lignite	Natural gas	Oil
1990	1.55	-	0,83
2003	1.40	0,45	0,79
2005	1,33	0,47	0,75
2006	1,34	0,43	0,75
2007	1,33	0,43	0,75

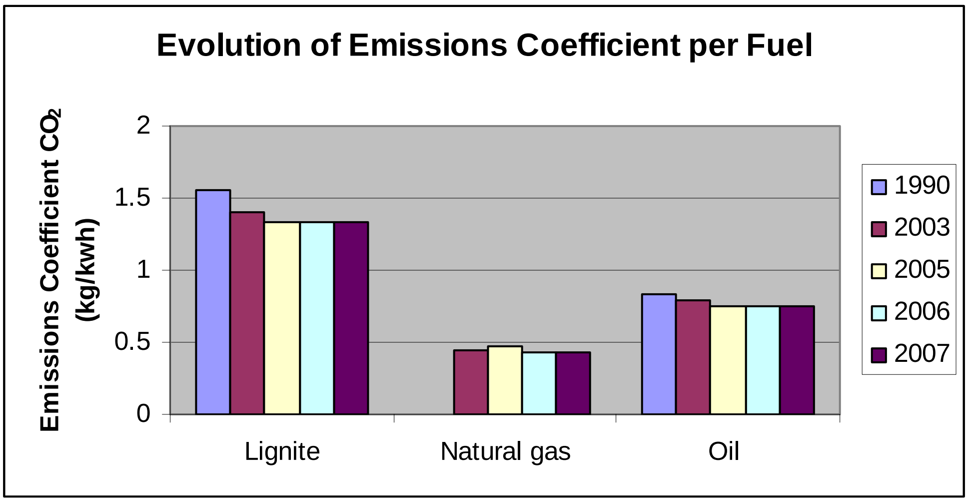


Figure 6.3

Table 6.4: The projected environmental costs per fuel

Year	Lignite				Natural Gas				Oil			
	Allowances CO_2 Price (€/t)				Allowances CO_2 Price (€/t)				Allowances CO_2 Price (€/t)			
	10	20	40	20.08 – current price 28/12	10	20	40	20.08 current price 28/12	10	20	40	20.08 current price 28/12
	Environmental cost from purchase allowances for each price (€/kwh)- $\frac{EC \times P}{1000}$											
1990	0	0	0	0	0	0	0	0	0	0	0	0
2003	0.014	0.028	0.056	0.028	0.005	0.009	0.018	0.009	0.008	0.016	0.032	0.016
2005	0.013	0.027	0.053	0.027	0.005	0.009	0.019	0.009	0.008	0.015	0.030	0.015
2006	0.013	0.027	0.053	0.027	0.004	0.009	0.017	0.009	0.008	0.015	0.030	0.015
2007	0.013	0.027	0.053	0.027	0.004	0.009	0.017	0.009	0.008	0.015	0.030	0.015

It is distinguishable three possible cases in carbon market (as table 6.4 figures):

- Firstly, the allowance price of being equal to 10€/t. In such case the environmental cost to purchase allowances is low enough, from 0.005 for natural gas up to 0.013 for lignite. More analytically, the supply of emissions allowances is sufficient to satisfy the demand.
- Secondly, the allowance price of being equal to 20€/t (the current situation in carbon market). This case is presented below.
- Finally, the most undesirable evolution for environmental improvement and sustainability is the case in which countries fell to compliance with Kyoto requirements resulting to pay the penalty (40€/t) for the excess emissions. In such case, the demand exceeds supply for emissions allowances (demand collapses), while the carbon market failure creates the necessity for the adoption more rigorous mechanisms to regulate environmental degradation. In short run, the consumers indirectly pay the penalty as the price rises but, in long run, economy asks for less energy consuming new technologies.

Table 6.4 presents the total cost per kwh for each fuel. According to current prices of emissions allowances (almost 20€/t) the "carbon cost" of the Kyoto protocol depends on the emissions coefficient. Thus, as lower is emissions coefficient as lower the CO_2 emissions become. Obviously, lignite has the highest "carbon cost", while the natural gas has the lowest. Specifically, in the current price (20,08€/t) the environmental cost for purchasing emissions allowances to produce energy by lignite is 0,027€/kwh for the triennium 2005-2007. On the other hand, the environmental cost that emissions trading creates to natural gas is 0,009 €/kwh. Therefore, as figure 6.1 and table 6.4 reveals the total fuel cost for electricity generation by lignite is almost (in 2003 prices) 0,027+0,019= 0,46€/kwh, while the fuel cost by natural gas is 0,039+0,009=0,048€/kwh. The results are presented in figure 6.5.

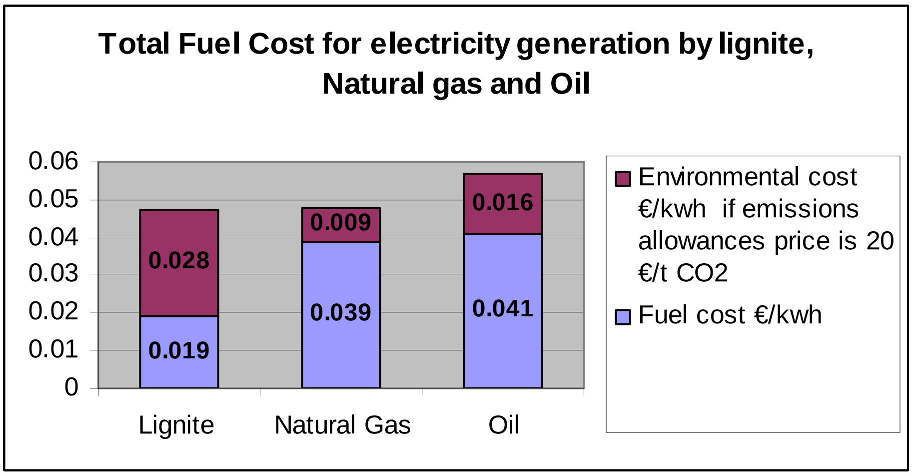


Figure 6.5

Conclusively, although the electricity generation by lignite implies the highest environmental cost, it remains the most cost effective natural source in energy sector. Lets now consider how an increase in price in electricity generation affects energy demand. In this context, the crucial factor is the price elasticity of demand for energy. The below analysis adopts a "top down" approach to analyze the "price elasticity of demand"[49]. By the term "price elasticity" is defined the percentage rise in demand for energy which is caused by a certain percentage rise in energy price. Thus, an increase in price will always cause a reduction in demand. For instance, a price rise of 2% might cause a reduction of 0.8 in demand, which is a price elasticity of –0.4 .

It should be noted that price elasticities in the short term are always lower than longer term elasticities as it takes time for consumers to react, practically, in such price increases by new technology. In general price elasticity of demand for energy is very low because energy consumption is not very price sensitive. It usually ranges from short term elasticity of –0.1 to a longer term elasticity of –0.4. A price elasticity as high

[49] London Economics have adopted a "top down approach".

as –0.6 reflects the commercialization of new alternative technologies. In this concept, it is obvious that the increasing prices by electricity generation due to CO_2 emissions purchasing, by the assumption that elasticity of energy demand is approximately –0.2, it is expected to reduce electricity consumption about –0.4*dQ/Q.

An alternative indicator about the significant consequences of the Kyoto Protocol operation is the oil market. One would have expected the price rises of the 30-year period 1970-2000 to urge countries to more efficient use of oil through technology innovations. The price elasticity in oil market is very low in both the short run (-0.055) and long run (-0,126). So, the elasticity of oil demand is inelastic in both terms and as it is expected the long run elasticity is greater than the corresponding short run value. According to the above analysis and the price elasticity of oil it is expected consumers to be in almost total imposed by environmental costs (0.016 €/kwh or 0.016€/tonne[50]). As Cooper states[51] in Greece "growth in oil consumption (2.2 % oil consumption per capita) exceeds economic growth (1.5% real GDP growth per capita).

Moreover, according to financial results that the Public Power Corporation S.A announced in November 2005, the sustained rise of oil and natural gas prices during the third quarter of 2005, combined with the further increase of expenditure related to CO_2 emission rights has already led to a reduction of operating profit to € 327,4 millions compared to € 513,5 millions in the corresponding period of 2004. In particular, an amount of €69 millions represents the expenditure for CO_2 emission rights. As the Public Power Corporation Chief Executive states "The profitability of the Company for the first 9 months of 2005 was reduced, mainly due to external factors. The sales increase as well as the small adjustment of tariffs (started 1st September 2005), was not enough to counterbalance the negative consequences of the crude oil and natural gas

[50] By the assumption that one tonne of oil produces $0.75t/CO_2$
[51] Cooper J.C.B, "Price Elasticity of Demand for Crude Oil for 23 countries", OPEC Review, 2003.

price increases as well as the environmental costs that was imposed to the Company for purchasing CO_2 emissions rights.

It is common practice that the fuel as well as the emissions costs, is reflected in the tariffs mechanism, which is not applied in the current Greek tariff policy. Please note that we have the lowest tariffs for households in Europe (specifically, they are 50% lower than the European average). Therefore, PPC is losing a substantial part of its profits.

The management is taking the necessary initiatives to achieve cost reduction and productivity enhancement.

The new business plan aims to improve the position of PPC and ensure further growth of the Company. Our top priority is to restructure the corporation via an upgrade program and prepare PPC for the new competitive environment".

Conclusively, the Public Power Corporation plans to internalise the cost of purchasing emission allowances into the energy prices. In accordance to the aforementioned analysis, in long run , consumers have not time to react in such policies due to the low elasticity of energy demand, while in long run the public participation could force for alternative policies.

7. Conclusions

Initially from prime economic thoughts the "Invisible hand" of Adam's Smith theory is a term to illustrate the principle of "enlightened self interest". As Adam Smith states, when an individual acts for his/her own good, he/she tends also to promote the good of his/her community. However, the tragedy of commons is an example where self-interest does not lead to social welfare. Global Warming is an appropriate example of the tragedy of "global" commons where the atmosphere is a commonly resource where users overexploit it, by the releasing of greenhouse gases.

Getting through an applicative orientation, the adoption of Kyoto Protocol by UNFCCC is a "bridge" intending to combine environmental protection with cost-effectiveness in order to save the stability of the globe. However, the Kyoto Protocol requires its ratification by the large emitters since the specific consuming "environmental good" has a significant characteristic: "the emitters of this resource are anything but equal". In this context, the appending U.S ratification remains a big issue as it threats its final efficacy. It appears that the UNFCCC should focus on the development of mechanisms that block the political expediencies and enforce the public participation.

Looking through a European level, the European Trading Scheme and National Allocation Plans figure a more well detailed policy for greenhouse gases effects. Firstly, the EU ETS enables companies exceeding individual CO_2 emission targets to buy allowances from "greener" ones. Secondly, the EU ETS creates direct and indirect costs. Direct costs arise as companies will need to invest in cleaner production methods. Significant direct costs do arise to particularly electricity sector the relevant companies need to swich to alternative production methods or buy allowances from carbon market. On the other hand, indirect costs take the form of higher electricity prices, which are mainly expected to passed on to individual and industrial consumers. A possible scenario could be the steadily high pricing until an even competition can be achieved in the EU power market. Moreover, an important role will play the coalition of power-intensive industries as they have warned that “in absence of real competition in the European power market, power companies will seek to charge their carbon allowance costs to client industries”.

In this dissertation our interest was focused on the Greek National Allocation Plan. By our research it was made clear that:

- The Greek NAP according to B-a-U scenario could not meet the objectives of EU Directive 2003/87/EC.
- Until now, the national policy has not adopted sufficient alternative production methods for the secure both the independence of Greek industries from emission allowances market and the sustainability of crucial natural resources for human being.
- According to questionnaire results, the responders intend to invest to R&D for clean technologies, only if the government provides enough incentives, while they admitted their plans to pass the environmental cost of EU ETS to consumers. Moreover, uncertainty about the EU ETS and its flexible mechanisms is diffused from all companies that are not acquainted yet with such regulative instruments.
- The power sector produces the largest part of CO2 emissions and thus our scenario gives him the prime role. Regarding the B-a-U scenario and the forecasting environmental cost that carbon market creates it is important to

scale the criteria for decision making process on power sector. In any case, a lot of attention should be paid on the attainment of cost effectiveness and environmental sustainability. In particular, in order to select the fuel to produce electricity the following criteria should be considered: 1. Selection the less costly and the most efficient fuel. 2. Estimation of the environmental value and abundance of each fuel. 3. Realization of a cost-benefit analysis for short run and long run period. Particularly, in case of Greece the less costly fuel is lignite. However, the lignite is not only the most polluted GHGs fuel but also its reserves are significantly reduced the recent years.

Finally, the increasing oil's price tendency that is enforced by current economic policies reveals the necessity for the promotion of alternative methods of production. Specifically, in long term the raise of oil price will push for the reduction of energy consuming activities. In such case, the market of emission allowances will be unpredictable in European and global level. Furthermore, the new facts in market of allowances is possible to dare domical changes in national environmental policies.

The point is that each policy should be accompanied by public participation implying that citizens should encourage environmental policies and measures. Not only does environment ensure human being but it also secures his well-being.

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Appendixes

Appendix 1: A full country check list on status of Kyoto Protocol ratification. Reproduced by the UNFCCC "Caring for climate", 2005

Country checklist

✓	AFGHANISTAN	✓✓	CHINA	✓✓	GRENADA
✓✓	ALBANIA	✓✓	COLOMBIA	✓✓	GUATEMALA
✓	ALGERIA	✓	COMOROS	✓✓	GUINEA
	ANDORRA	✓	CONGO	✓	GUINEA-BISSAU
✓	ANGOLA	✓✓	COOK ISLANDS	✓✓	GUYANA
✓✓	ANTIGUA AND BARBUDA	✓✓	COSTA RICA	✓	HAITI
✓✓	ARGENTINA	✓	COTE D'IVOIRE		HOLY SEE
✓✓	ARMENIA	✓■■	CROATIA	✓✓	HONDURAS
✓■■■	AUSTRALIA	✓✓	CUBA	✓✓■■	HUNGARY
✓✓■■■	AUSTRIA	✓✓	CYPRUS	✓✓■■■	ICELAND
✓✓	AZERBAIJAN	✓✓■■	CZECH REPUBLIC	✓✓	INDIA
✓✓	BAHAMAS	✓	DEMOCRATIC PEOPLE'S	✓✓	INDONESIA
✓	BAHRAIN		REPUBLIC OF KOREA	✓	IRAN (ISLAMIC REPUBLIC OF)
✓✓	BANGLADESH	✓✓	DEMOCRATIC REPUBLIC OF		IRAQ
✓✓	BARBADOS		THE CONGO	✓✓■■■	IRELAND
✓■	BELARUS	✓✓■■■	DENMARK	✓✓	ISRAEL
✓✓■■■	BELGIUM	✓✓	DJIBOUTI	✓✓■■■	ITALY
✓✓	BELIZE	✓✓	DOMINICA	✓✓	JAMAICA
✓✓	BENIN	✓✓	DOMINICAN REPUBLIC	✓✓■■■	JAPAN
✓✓	BHUTAN	✓✓	ECUADOR	✓✓	JORDAN
✓✓	BOLIVIA	✓	EGYPT	✓	KAZAKHSTAN
✓	BOSNIA AND HERZEGOVINA	✓✓	EL SALVADOR	✓✓	KENYA
✓✓	BOTSWANA	✓✓	EQUATORIAL GUINEA	✓✓	KIRIBATI
✓✓	BRAZIL	✓✓	ERITREA	✓✓	KUWAIT
	BRUNEI DARUSSALAM	✓✓■■	ESTONIA	✓✓	KYRGYZSTAN
✓✓■■	BULGARIA	✓	ETHIOPIA	✓✓	LAO PEOPLE'S DEMOCRATIC
✓✓	BURKINA FASO	✓✓	FIJI		REPUBLIC
✓✓	BURUNDI	✓✓■■■	FINLAND	✓✓■■	LATVIA
✓✓	CAMBODIA	✓✓■■■	FRANCE	✓	LEBANON
✓✓	CAMEROON	✓	GABON	✓✓	LESOTHO
✓✓■■■	CANADA	✓✓	GAMBIA	✓✓	LIBERIA
✓	CAPE VERDE	✓✓	GEORGIA	✓	LIBYAN ARAB JAMAHIRIYA
✓	CENTRAL AFRICAN REPUBLIC	✓✓■■■	GERMANY	✓✓■■	LIECHTENSTEIN
✓	CHAD	✓✓	GHANA	✓✓■■	LITHUANIA
✓✓	CHILE	✓✓■■■	GREECE	✓✓■■■	LUXEMBOURG

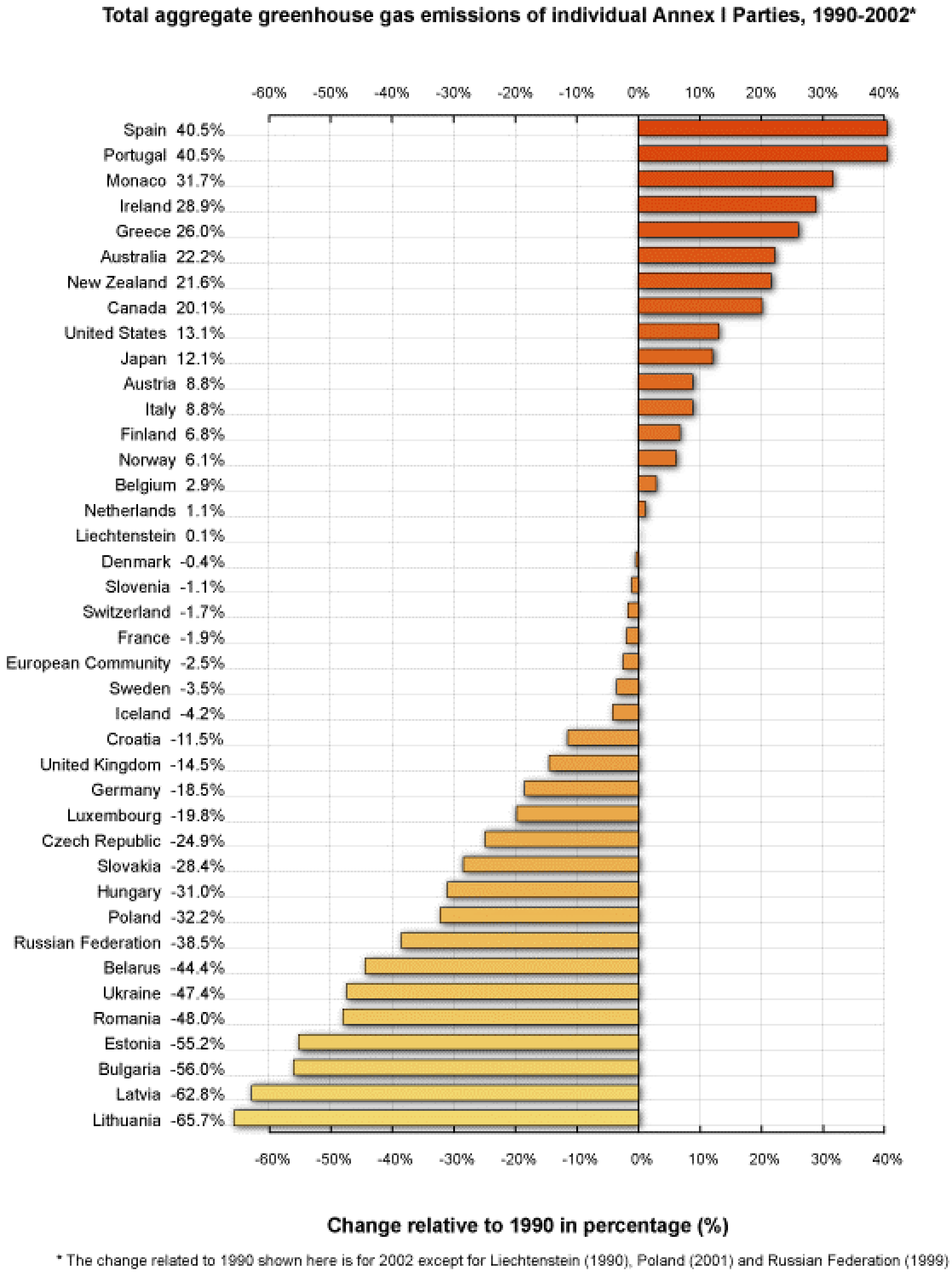
✓✓	MADAGASCAR	✓✓■■	POLAND	✓✓	THAILAND
✓✓	MALAWI	✓✓■■■	PORTUGAL	✓✓	THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
✓✓	MALAYSIA	✓✓	QATAR	✓✓	TOGO
✓✓	MALDIVES	✓✓	REPUBLIC OF KOREA	✓	TONGA
✓✓	MALI	✓✓	REPUBLIC OF MOLDOVA	✓✓	TRINIDAD AND TOBAGO
✓✓	MALTA	✓✓■■	ROMANIA	✓✓	TUNISIA
✓✓	MARSHALL ISLANDS	✓■■	RUSSIAN FEDERATION	✓■	TURKEY
✓	MAURITANIA	✓✓	RWANDA	✓✓	TURKMENISTAN
✓✓	MAURITIUS	✓	SAINT KITTS AND NEVIS	✓✓	TUVALU
✓✓	MEXICO	✓✓	SAINT LUCIA	✓✓	UGANDA
✓✓	MICRONESIA (FEDERATED STATES OF)	✓✓	SAINT VINCENT AND THE GRENADINES	✓✓■■	UKRAINE
✓■■	MONACO	✓✓	SAMOA	✓✓	UNITED ARAB EMIRATES
✓✓	MONGOLIA	✓	SAN MARINO	✓✓■■■	UNITED KINGDOM OF GREAT BRITAIN AND NORTHEN IRELAND
✓✓	MOROCCO	✓	SAO TOME AND PRINCIPE	✓✓	UNITED REPUBLIC OF TANZANIA
✓✓	MOZAMBIQUE	✓✓	SAUDI ARABIA	✓■■■	UNITED STATES OF AMERICA
✓✓	MYANMAR	✓✓	SENEGAL	✓✓	URUGUAY
✓✓	NAMIBIA	✓	SERBIA AND MONTENEGRO	✓✓	UZBEKISTAN
✓✓	NAURU	✓✓	SEYCHELLES	✓✓	VANUATU
✓	NEPAL	✓	SIERRA LEONE	✓✓	VENEZUELA
✓✓■■■	NETHERLANDS	✓	SINGAPORE	✓✓	VIET NAM
✓✓■■■	NEW ZEALAND	✓✓■■	SLOVAKIA	✓✓	YEMEN
✓✓	NICARAGUA	✓✓■■	SLOVENIA	✓	ZAMBIA
✓✓	NIGER	✓✓	SOLOMON ISLANDS	✓	ZIMBABWE
✓✓	NIGERIA		SOMALIA	✓✓■■■	EUROPEAN COMMUNITY
✓✓	NIUE	✓✓	SOUTH AFRICA		
✓✓■■■	NORWAY	✓✓■■■	SPAIN		
✓✓	OMAN	✓✓	SRI LANKA		
✓✓	PAKISTAN	✓✓	SUDAN		
✓✓	PALAU	✓	SURINAME		
✓✓	PANAMA	✓	SWAZILAND		
✓✓	PAPUA NEW GUINEA	✓✓■■■	SWEDEN		
✓✓	PARAGUAY	✓✓■■■	SWITZERLAND		
✓✓	PERU	✓	SYRIAN ARAB REPUBLIC		
✓✓	PHILIPPINES	✓	TAJIKISTAN		

■ Annex I
■ Annex I EIT*
■ Annex II
■ Annex B (Kyoto Protocol)
✓ Ratified** UNFCCC
✓ Ratified** the Kyoto Protocol

* Annex I country with economy in transition.
** Indicates country has ratified, or acceded to, or accepted, or approved the treaty in question.

The status of ratification is subject to change. For the latest update consult <unfccc.int>.

Appendix 2: Presents a list of total aggregate greenhouse gas emissions of individual Annex I Parties 1990-2002.



Appendix 3: Carbon emissions, Population and Gross Domestic Products in OECD countries. The sources for information used are:

For population, GDP, CO2 emissions per capita and share of world total: "Human Development Report in 2005" by OECD.

For Kyoto Target for EU countries, burden sharing country: www.unfccc.int

The list is sorted by alphabetical order

	Country	Total population 2003 (millions)	GDP 2003 billions	CO_2 emissions per capita (metric tons)	share of world total	Kyoto Target for Annex I countries (for EU countries, burden sharing target)
1	Albania	3.1	6.1	0.8	(.)	
2	Algeria	31.9	66.5	2.9	0.4	
3	Angola	15.0	13.2	0.5	(.)	
4	Antigua and Barbuda	0.1	0.8	4.7	(.)	
5	Argentina	38.0	129.6	3.5	0.6	
6	Armenia	3.0	2.8	1.0	(.)	
7	Australia	19.7	522.4	18.3	1.5	8
8	Austria	8.1	253.1	7.8	0.3	-13
9	Azerbaijan	8.3	7.1	3.4	0.1	
10	Bahamas	0.3	5.3	6.7	(.)	
11	Bahrain	0.7	.. d	30.6	0.1	
12	Bangladesh	136.6	51.9	0.3	0.1	
13	Barbados	0.3	2.6	4.6	(.)	
14	Belarus	9.9	17.5	6.0	0.3	
15	Belgium	10.4	301.9	6.8	0.4	-7.5
16	Belize	0.3	1.0	3.1	(.)	
17	Benin	7.9	3.5	0.3	(.)	
18	Bhutan	2.1	0.7	0.2	(.)	
19	Bolivia	8.8	7.9	1.2	(.)	
20	Bosnia and Herzegovina	3.9	7.0	4.8	0.1	
21	Botswana	1.8	7.5	2.3	(.)	
22	Brazil	181.4	492.3	1.8	1.3	
23	Brunei Darussalam	0.4	..	17.7	(.)	
24	Bulgaria	7.8	19.9	5.3	0.2	-8

25	Burkina Faso	12.4	4.2	0.1	(.)	
26	Burundi	7.0	0.6	(.)	(.)	
27	Cambodia	13.5	4.2	(.)	(.)	
28	Cameroon	15.7	12.5	0.2	(.)	
29	Canada	31.6	856.5	16.5	1.9	-6
30	Cape Verde	0.5	0.8	0.3	(.)	
31	Central African Republic	3.9	1.2	0.1	(.)	
32	Chad	9.1	2.6	(.)	(.)	
33	Chile	16.0	72.4	3.6	0.3	
34	China	1,300.0[52]	1,417.0	2.7	12.1	
35	Colombia	44.2	78.7	1.3	0.3	
36	Comoros	0.8	0.3	0.1	(.)	
37	Congo	3.8	3.6	0.6	(.)	
38	Congo,Dem. Rep. Of the	54.2	5.7	(.)	(.)	
39	Costa Rica	2.1	17.4	1.4	(.)	
40	Côted'Ivoire	17.6	13.7	0.4	(.)	
41	Croatia	4.5	28.8	4.7	0.1	
42	Cuba	11.2	..	2.1	0.1	
43	Cyprus	0.8	11.4	8.3	(.)	
44	Czech Republic	10.2	89.7	11.2	0.5	-8
45	Denmark	5.4	211.9	8.9	0.2	-21
46	Djibouti	0.8	0.6	0.5	(.)	
47	Dominica	0.1	0.3	1.5	(.)	
48	Dominican Republic	8.6	16.5	2.5	0.1	
49	Ecuador	12.9	27.2	2.0	0.1	
50	Egypt	71.3	82.4	2.1	0.6	
51	El Salvador	6.6	14.9	1.0	(.)	
52	Equatorial Guinea	0.5	2.9	0.4	(.)	
53	Eritrea	4.1	0.8	0.2	(.)	
54	Estonia	1.3	9.1	11.8	0.1	-8
55	Ethiopia	73.8	6.7	0.1	(.)	
56	Fiji	0.8	2.0	1.6	(.)	
57	Finland	5.2	161.9	12.0	0.2	0
58	France	60.0	1,757.6	6.2	1.6[53]	0
59	Gabon	1.3	6.1	2.6	(.)	
60	Gambia	1.4	0.4	0.2	(.)	
61	Georgia	4.6	4.0	0.7	(.)	
62	Germany	82.6	2,403.2	9.8	3.4	-21
63	Ghana	21.2	7.6	0.4	(.)	
64	Greece	11.1	172.2	8.5	0.4	25
65	Grenada	0.1	0.4	2.3	(.)	
66	Guatemala	12.0	24.7	0.9	(.)	
67	Guinea	9.0	3.6	0.1	(.)	
68	Guinea-Bissau	1.5	0.2	0.2	(.)	

[5252] Population estimates include Taivan, Province of China
[53] Includes Monaco

69	Guyana	0.7	0.7	2.2	(.)	
70	Haiti	8.3	2.9	0.2	(.)	
71	Honduras	6.9	7.0	0.9	(.)	
72	Hong Kong, China (SAR)	6.9	156.7	5.2	0.1	
73	Hungary	10.2	82.7	5.6	0.2	-6
74	Iceland	0.3	10.5	7.7	(.)	10
75	India	1,070.8	600.6	1.2	4.7	
76	Indonesia	217.4	208.3	1.4	1.2	
77	Iran,Islamic Rep.of	68.2	137.1	5.3	1.4	
78	Ireland	4.0	153.7	11.0	0.2	13
79	Israel	6.5	110.2	11.0	0.3	
80	Italy	58.0	1,468.3	7.5	1.9[54]	-6.5
81	Jamaica	2.6	8.1	4.1	(.)	
82	Japan	127.7	4,300.9	9.4	5.2	-6
83	Jordan	5.4	9.9	3.2	0.1	
84	Kazakhstan	14.9	29.7	9.9	0.5	
85	Kenya	32.7	14.4	0.2	(.)	
86	Korea,	of	605.3	9.4	1.9	
87	Kuwait	2.5	41.7	24.6	0.2	
88	Kyrgyzstan	5.1	1.9	1.0	(.)	
89	Lao People's Dem.Rep.	5.7	2.1	0.2	(.)	
90	Latvia	2.3	11.1	2.7	(.)	-8
91	Lebanon	3.5	19.0	4.7	0.1	
92	Lesotho	1.8	1.1	..	..	
93	Libyan Arab Jamahiriya	5.6	.. d	9.1	0.2	
94	Lithuania	3.5	18.2	3.6	0.1	-8
95	Luxembourg	0.5	26.5	21.1	(.)	-28
96	Macedonia, TFYR	2.0	4.7	5.1	(.)	
97	Madagascar	17.6	5.5	0.1	(.)	
98	Malawi	12.3	1.7	0.1	(.)	
99	Malaysia	24.4	103.7	6.3	0.6	
100	Maldives	0.3	0.7	3.4	(.)	
101	Mali	12.7	4.3	(.)	(.)	
102	Malta	0.4	4.9	7.5	(.)	
103	Mauritania	2.9	1.1	1.1	(.)	
104	Mauritius	1.2	5.2	2.6	(.)	
105	Mexico	104.3	626.1	3.7	1.8	
106	Moldova,	of	2.0	1.6	(.)	
107	Mongolia	2.6	1.3	3.3	(.)	
108	Morocco	30.6	43.7	1.4	0.2	
109	Mozambique	19.1	4.3	0.1	(.)	
110	Myanmar	49.5	..	0.2	(.)	
111	Namibia	2.0	4.3	1.1	(.)	
112	Nepal	26.1	5.9	0.2	(.)	

[54] Includes Liechenstein

113	Netherlands	16.1	511.5	9.4	0.6	-6
114	New Zealand	3.9	79.6	8.7	0.1	0
115	Nicaragua	5.3	4.1	0.7	(.)	
116	Niger	13.1	2.7	0.1	(.)	
117	Nigeria	125.9	58.4	0.4	0.2	
118	Norway	4.6	220.9	12.2	0.2	
119	Occupied PalestinianTerritories	3.5	3.5	..	..	
120	Oman	2.5	.. d	12.1	0.1	
121	Pakistan	151.8	82.3	0.7	0.5	
122	Panama	3.1	12.9	2.0	(.)	
123	Papua New Guinea	5.7	3.2	0.4	(.)	
124	Paraguay	5.9	6.0	0.7	(.)	
125	Peru	27.2	60.6	1.0	0.1	
126	Philippines	80.2	80.6	0.9	0.3	
127	Poland	38.6	209.6	7.7	1.3	-6
128	Portugal	10.4	147.9	6.0	0.3	27
129	Qatar	0.7	.. d	53.1	0.2	
130	Romania	21.9	57.0	4.0	0.4	-8
131	Russian Federation	144.6	432.9	9.9	6.2	0
132	Rwanda	8.8	1.6	0.1	(.)	
133	Saint Kitts and Nevis	(.)	0.3	2.8	(.)	
134	Saint Lucia	0.2	0.7	2.4	(.)	
135	Saint Vincent and the Grenadines	0.1	0.4	1.6	(.)	
136	Samoa (Western)	0.2	0.3	0.8	(.)	
137	São Tomé and Principe	0.1	0.1	0.6	(.)	
138	Saudi Arabia	23.3	214.7	15.0	1.6	
139	Senegal	11.1	6.5	0.4	(.)	
140	Seychelles	0.1	0.7	6.8	(.)	
141	Sierra Leone	5.1	0.8	0.1	(.)	
142	Singapore	4.2	91.3	13.8	0.3	
143	Slovakia	5.4	32.5	6.8	0.2	-8
144	Slovenia	2.0	27.7	7.8	0.1	-8
145	Solomon Islands	0.5	0.3	0.4	(.)	
146	South Africa	46.9	159.9	7.4	1.4	
147	Spain	42.1	838.7	7.3	1.2	15
148	Sri Lanka	20.4	18.2	0.5	(.)	
149	Sudan	34.9	17.8	0.3	(.)	
150	Suriname	0.4	1.2	5.1	(.)	
151	Swaziland	1.0	1.8	0.9	(.)	
152	Sweden	9.0	301.6	5.8	0.2	4
153	Switzerland	7.2	320.1	5.7	0.2	-8
154	Syrian Arab Republic	18.1	21.5	2.8	0.2	
155	Tajikistan	6.4	1.6	0.7	(.)	
156	Tanzania, U. Rep. Of	36.9	10.3	0.1	(.)	

157	Thailand	63.1	143.0	3.7	0.9	
158	Timor-Leste	0.8	0.3	..	..	
159	Togo	5.8	1.8	0.3	(.)	
160	Tonga	0.1	0.2	1.1	(.)	
161	Trinidad and Tobago	1.3	10.5	31.9	0.1	
162	Tunisia	9.9	25.0	2.3	0.1	
163	Turkey	71.3	240.4	3.0	1.0	
164	Turkmenistan	4.7	6.2	9.1	0.2	
165	Uganda	26.9	6.3	0.1	(.)	
166	Ukraine	47.5	49.5	6.4	1.5	0
167	United Arab Emirates	4.0	.. d	25.1	0.3	
168	United Kingdom	59.3	1,794.9	9.2	2.5	-12.5
169	United States	292.6	10,948.5[55]	20.1	24.4	-7
170	Uruguay	3.4	11.2	1.2	(.)	
171	Uzbekistan	25.8	9.9	4.8	0.5	
172	Vanuatu	0.2	0.3	0.4	(.)	
173	Venezuela	25.8	85.4	4.3	0.7	
174	Viet Nam	82.0	39.2	0.8	0.3	
175	Yemen	19.7	10.8	0.7	(.)	
176	Zambia	11.3	4.3	0.2	(.)	
177	Zimbabwe	12.9	.. d	1.0	0.1	

[55] In theory, for the United States the Value of GDP in purchasing power parity (PPP) US dollars should be the same as that in US dollars, but practical issues arising in the calculation of the PPP US dollar GDP prevent this.

Appendix 4:

Allocation of allowances per installation for the period 2005-2007

No	CODE.	INSTALLATION	TOTAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2)	ANNUAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2/y)
1	1-1	TPS LIPTOL	1,116,138	372,046
2	1-2	TPS PTOLEMAIDA	14,078,365	4,692,788
3	1-3	TPS KARDIA	29,493,437	9,831,146
4	1-4	TPS AGIOS DIMITRIOS	38,844,314	12,948,105
5	1-5	TPS AMINTAIO	15,680,415	5,226,805
6	1-6	TPS MEGALOPOLI (Units I, II & III)	13,390,825	4,463,608
7	1-7	TPS MEGALOPOLI (Unit 4)	7,814,881	2,604,960
8	1-8	TPS FLORINA	7,931,474	2,643,825
9	1-9	TPS AGIOS GEORGIOS	2,002,832	667,611
10	1-10	TPS LAVRIO	9,407,595	3,135,865
11	1-11	TPS KOMOTINI	2,847,574	949,191
12	1-12	TPS ALIVERI	3,312,077	1,104,026
13	1-13	TPS LINOPERAMATA	2,750,440	916,813
14	1-14	TPS CHANIA	2,296,687	765,562
15	1-15	TPS SORONI RHODES	1,359,908	453,303
16	1-16	APP LESVOS	472,814	157,605
17	1-17	APP SYROS	195,148	65,049
18	1-18	APP KOS	376,391	125,464
19	1-19	APP CHIOS	290,329	96,776
20	1-20	APP SAMOS	214,965	71,655
21	1-21	APP PAROS	279,616	93,205
22	1-22	APP MIKONOS	151,158	50,386
23	1-23	APP THIRA	170,784	56,928
24	1-24	APP LIMNOS	103,544	34,515
25	1-25	APP MILOS	71,660	23,887
26	1-26	APP KARPATHOS	55,425	18,475
27	1-27	APP KALIMNOS	97,138	32,379
28	1-28	APP IKARIA	47,415	15,805
29	1-29	TPS ATHERONOLAKOS	1,038,421	346,140
30	1-30	HERON THERMOELECTRIC S.A.	307,604	102,535
TOTAL 1 (ELECTRICITY GENERATION > 20 MW)			**156,199,372**	**52,066,457**
31	2-1	ALUMINIUM DE GRECE S.A.	1,548,996	516,332
32	2-2	ELVAL HELLENIC ALUMINIUM INDUSTRY S.A.	191,380	63,793
33	2-3	HELIOFIN	27,246	9,082
34	2-4	MAXIM S.A.	63,533	21,178
35	2-5	ANEZOULAKIS BROS FIERATEX S.A.	44,676	14,892
36	2-6	HELLENIC SUGAR INDUSTRY (ORESTIADA FACTORY)	190,419	63,473
37	2-7	HELLENIC SUGAR INDUSTRY (PLATI IMATHIAS FACTORY)	199,634	66,545
38	2-8	HELLENIC SUGAR INDUSTRY (LARISSA FACTORY)	202,878	67,626
39	2-9	HELLENIC SUGAR INDUSTRY (SERRES FACTORY)	120,925	40,308
40	2-10	HELLENIC SUGAR INDUSTRY (XANTHI FACTORY)	122,641	40,880

No	CODE.	INSTALLATION	TOTAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2)	ANNUAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2/y)
41	2-11	MEVGAL S.A.	29,428	9,809
42	2-12	NATIONAL & KAPODISTRIAN UNIVERSITY OF ATHENS	9,514	3,171
43	2-13	UNIVERSITY OF PATRAS	7,709	2,570
44	2-14	HALYVOURGIA THESSALIAS (ROLLING MILL PLANT)	71,517	23,839
45	2-15	KAVALA OIL	308,763	102,921
46	2-16	GRECIAN MAGNESITE S.A.	353,344	117,781
		TOTAL 2 (OTHER COMBUSTION > 20 MW)	**3,492,603**	**1,164,201**
47	3-1	HELLENIC PETROLEUM S.A. (ASPROPYRGOS REFINERY)	4,738,409	1,579,470
48	3-2	HELLENIC PETROLEUM S.A. (THESSALONIKI REFINERY)	1,110,505	370,168
49	3-3	MOTOR OIL HELLAS - CORINTH REFINERIES S.A.	3,619,891	1,206,630
50	3-4	HELLENIC PETROLEUM S.A. (ELEFSIS REFINERY)	827,421	275,807
		TOTAL 3 (REFINERIES)	**10,296,226**	**3,432,075**
51	4-1	LARCO GENERAL MINING AND METALLURGICAL S.A.	2,421,885	807,295
		TOTAL 4 (SINTERING)	**2,421,885**	**807,295**
52	5-1	HELLINIKI HALYVOURGIA S.A.	254,780	84,927
53	5-2	HALYVOURGIKI INC.	638,248	212,749
54	5-3	SIDENOR S.A.	465,758	155,253
55	5-4	HALYVOURGIA THESSALIAS	430,814	143,605
56	5-5	SOVEL S.A.	603,050	201,017
		TOTAL 5 (IRON & STELL)	**2,392,650**	**797,550**
57	6-1	HERAKLES GENERAL CEMENT COMPANY S.A. - VOLOS "OLIMPOS" PLANT	8,536,435	2,845,478
58	6-2	HERAKLES GENERAL CEMENT COMPANY S.A. – PLANT II	4,220,611	1,406,870
59	6-5	TITAN CEMENT COMPANY S.A. –PATRAS PLANT	3,232,793	1,077,598
60	6-6	TITAN CEMENT COMPANY S.A. – ELEFSINA PLANT	418,892	139,631
61	6-7	TITAN CEMENT COMPANY S.A. – KAMARI PLANT	5,929,101	1,976,367
62	6-4	TITAN CEMENT COMPANY S.A. – EFKARPIA THESSALONIKI PLANT	3,750,381	1,250,127
63	6-3	HERAKLES GENERAL CEMENT COMPANY S.A. – PLANT III (ex HALKIS CEMENT GROUP S.S.)	5,494,265	1,831,422
64	6-8	HALYPS BUILDING MATERIALS S.A	1,632,796	544,265
		TOTAL 6 (CEMENT)	**33,215,274**	**11,071,758**
65	7-1	ASVESTOLAMIKI – DOUKERIS A	89,430	29,810
66	7-2	PARASCHOU, ST., BROS S.A.	60,078	20,026
67	7-3	"THE UNION" LIME INDUSTRY – DOUKERIS CHR.	153,397	51,132
68	7-4	CRETAN LIME INDUTRY S.A.	68,003	22,668
69	7-5	KYKNOS S.A.	119,984	39,995
70	7-6	MACEDONIAN LIME INDUSTRY TITAN	153,161	51,054
71	7-7	RAIKOS S.A.	733,707	244,569
72	7-8	PASTOURMATZIS & CO.	65,096	21,699
73	7-9	TSIRIGOTIS, A.L. & A.N., S.A.	292,162	97,387
74	7-10	AIMOS S.A.	34,697	11,566
75	7-11	CaO THESSALIAN LIME INDUSTRY S.A.	186,152	62,051
76	7-12	VELESTINO LIME S.A.	96,653	32,218
77	7-13	DEVETZOGLOU, B. A., S.A.	258,882	86,294
78	7-14	BOUGAS BROS	54,484	18,161

No	CODE.	INSTALLATION	TOTAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2)	ANNUAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2/y)
79	7-15	TSAROUCHAS	48,564	16,188
80	7-16	OLYMPOS THESSALIAN LIME INDUSTRY – SIAMIS & CO.	88,558	29,519
		TOTAL 7 (LIME)	**2,503,008**	**834,336**
81	8-1	VALAVANIS, N., BROS S.A.	54,273	18,091
82	8-2	YIOULA GLASSWORKS S.A.	196,597	65,532
83	8-3	CRONOS GLASSWORKS S.A.	65,461	21,820
		TOTAL 8 (GLASS)	**316,331**	**105,444**
84	9-1	AKEK S.A.	69,438	23,146
85	9-2	ANAGNOSTARAS, A., BROS S.A.	44,818	14,939
86	9-3	VAVOULIOTIS – GOUNARIS – MITAKIS "CHALKIS" S.A. (EVIA PLANT)	100,333	33,444
87	9-4	VAVOULIOTIS – GOUNARIS – MITAKIS "CHALKIS" S.A. (VIOTIA PLANT)	158,043	52,681
88	9-5	VEAK S.A.	82,022	27,341
89	9-6	VITROUVIT S.A.	33,172	11,057
90	9-7	GALANIS, J., S.A.	10,290	3,430
91	9-8	KATSIKIS, G., CERAMICS INDUSTRY S.A.	32,680	10,893
92	9-9	CERAMICS ALLATINI S.A.	13,539	4,513
93	9-10	HALKIDIKI S.A. BRICKS INDUSTRY	59,476	19,825
94	9-11	KERAMOURGIKI VASSILIKOU S.A.	29,572	9,857
95	9-12	MAMAKOS A. & CO.	343	114
96	9-13	KEPAMOTECHNIKI ARGOUS S.A.	7,211	2,404
97	9-14	AGRINIO TILE INDUSTRY S.A.	32,584	10,861
98	9-15	D.I. KOKKINOGENIS S.A.	56,236	18,745
99	9-16	MALIOURIS, B., S.A.	67,704	22,568
100	9-17	MAGIARIS S.A.	8,224	2,741
101	9-18	MAVRIDI S.A.	57,466	19,155
102	9-19	PANAGIOTOPOULOS TILE & BRICK IND. S.A.	50,636	16,879
103	9-20	PLINTHOKERAM LTD.	21,446	7,149
104	9-21	ZARKADOULAS, CHR., BROS S.A.	15,587	5,196
105	9-22	RETHYMNIOTIKI BRICK INDUSTRY S.A.	47,165	15,722
106	9-23	ROIDI BROS	16,360	5,453
107	9-24	SAPOUNAS, TH., BROS & CO "THE 8 BROTHERS" S.A.	138,322	46,107
108	9-25	SOLOMOU BROS	32,783	10,928
109	9-26	TECHNORAMIKI S.A.	20,420	6,807
110	9-27	FILKERAM - JOHNSON S.A.	109,282	36,427
111	9-28	KOTHALIS S.A.	152,108	50,703
112	9-29	ARISTEIDOPOULOS BROS CERAMICS S.A.	23,070	7,690
113	9-30	KALOGIANNI BROS	5,971	1,990
114	9-31	ARGOS TILES S.A.	11,828	3,943
115	9-32	KERAMOURGIKI RAFINAS S.A.	66,778	22,259
116	9-33	SPARTI CERAMIC INDUSTRY	13,648	4,549
117	9-34	MITSIADI BROS – PAPASTERGIOU A.	7,620	2,540
118	9-35	MITSIADIS D. & S.	8,834	2,945
119	9-36	MOUGIOS I. "TITAN"	17,844	5,948
120	9-37	SAKELLARAKOS, G., S.A.	29,072	9,691
121	9-38	TSASERLIS	2,228	743

No	CODE.	INSTALLATION	TOTAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2)	ANNUAL ALLOWANCES FOR THE PERIOD 2005-2007 (t CO2/y)
122	9-39	CHRISTODOULIDIS S.A. TILES INDUSTRY	36,570	12,190
123	9-40	TERRA S.A.	578,181	192,727
124	9-41	THESPROTIKI KERAMOURGHIA S.A.	57,882	19,294
125	9-42	PRINTZIS, D., BROS S.A.	11,203	3,734
126	9-43	KATSANIS, G., S.A.	18,766	6,255
TOTAL 9 (CERAMICS)			**2,356,754**	**785,585**
127	10-1	GEORGIA PACIFIC HELLAS S.A.	32,119	10,706
128	10-2	ATHENS PAPER MILL S.A.	74,901	24,967
129	10-3	V.E.K.A. PAPER MFG CO. S.A.	10,408	3,469
130	10-4	VIOCHARTIKI PAPER MILL S.A.	39,345	13,115
131	10-5	VIS CONTAINERS MFG CO. S.A.	37,527	12,509
132	10-6	MEL MACEDONIAN PAPER MILLS S.A.	103,984	34,661
133	10-7	PACO PAPER INDUSTRY A. VL. KOLIOPOULOS S.A. (FTHIOTIS PLANT)	59,958	19,986
134	10-8	PATRAS PAPER MILLS S.A.	15,437	5,146
135	10-9	TECHNOCART S.A.	17,387	5,796
136	10-10	THRACE PAPER MILL S.A.	69,430	23,143
137	10-11	KOMOTINI PAPER MILL S.A.	51,249	17,083
138	10-12	PATRAS PAPER MILLS – KORONIOTIS S.A.	8,467	2,822
139	10-13	SONOCO HELLAS S.A.	14,422	4,807
140	10-14	FTHIOTIS PAPER MILL S.A.	51,338	17,113
141	10-15	PACO PAPER INDUSTRY A. VL. KOLIOPOULOS S.A. (KORINTHIA PLANT)	10,482	3,494
TOTAL 10 (PAPER)			**596,454**	**198,818**
TOTAL ALLOWANCES FOR EXISTING INSTALLATIONS			**213,790,556**	**71,263,519**

Appendix 5

QUESTIONNAIRE

QUESTION 1

Do you know the National Allocation Plan of Emissions Allowances (NAP)?

1. Yes I know the NAP
2. I know only certain fundamental points from the NAP
3. No I don't know the NAP

QUESTION 2

Did you participate in the configuration of National Allocation Plan?

1. Yes we participated
2. No we did not participate
3. No we did not participate but we would like to have participated

QUESTION 3

Are you satisfied from the National Allocation Plan of Emissions Allowances (NAP)?

Do you have any remark?

1. Yes we are satisfied from the NAP
2. No we are not satisfied because according to historical emissions our company deserves more emission allowances.

3. No we are not satisfied because we disagree with the method of determination of the share of installations covered by the Directive to the total emissions (The forecasting Approach)

4. No we are not satisfied.

Mark the reason

QUESTION 4

Does the number of emission allowances satisfy your needs? If it doesn't what you intend to do?

1. Yes it satisfies our needs. It is also possible to become sellers.
2. Yes it satisfies our needs, we don't need excess allowances.
3. No it does not satisfy. We intend to face the increasing needs by purchasing allowances.
4. No it does not satisfy. We intend to face the increasing demand with the development of other methods (for example methods environmental friendly).
5. No it does not satisfy. Mark the reason

QUESTION 5 *(it is answered provided that it has been selected in the previous question choices 3-5)*

Do you believe that your company has the possibility to face the excess demand of purchasing emission allowances via alternative policies and measures (for example new technologies, alternative fuels) in order to decrease its dependence from the carbon market?

1. A lot of possibilities.

2. Certain possibilities.

3. Null possibilities

QUESTION 6

Do you believe that in level of country exist possibilities of achieving the Community objective (+ 25%) by the adoption of alternative policies and measures?

1. A lot of possibilities
2. Certain possibilities
3. No possibility

QUESTION 7

What sources of information does your company primarily use to keep updated about the emerging greenhouse gases emission markets?

1. National authorities

Mark

2. Genera newspapers - journals, TV or radio
3. Non-Governmental organizations
4. The scientific community (scientific books/articles, reports, seminars)
5. Other

Please specify below

QUESTION 8

The information that you have they are:

1. Efficient
2. Reasonably Efficient
3. Inefficient
4. Other

QUESTION 9

Do you the allowance price at this moment?

1. Yes it is (specify).
2. No I do not know

QUESTION 10

Which price do you believe to prevail in carbon market?

1. 10-15€ / tone
2. 15-20€ / tone
3. 20-30€ / tone
4. 30-40€ / tone
5. I do not know

QUESTION 11

How do you believe that the EU Emission Trading System to operate?

1. Many sellers and buyers
2. The buyers exceed the sellers
3. The sellers exceed the buyers
4. Other

Please specify below

QUESTION 12

Does the rise of oil price influence your future plans? How?

1. No

2. Yes it influences them. We invest more capital in new energy sources.
3. Yes it influences them. We try to decrease the increasing cost of production via the reduction of energy consuming activities.
4. Yes it influences them. Specify one other reason

QUESTION 13

Do you believe that the additional policies (Renewable sources, Natural Gas) for the achievement of Kyoto target will be applied?

1. Yes they have already applied
2. Yes they will be applied
3. No they will not be applied

QUESTION 14

Do you invest in Research and Development for clean technologies?

1. Yes we invest. Specify the percentage.
2. No we do not invest.

QUESTION 15

Regarding Joint Implementation and Clean Development mechanisms, Do you plan to participate in such projects in order to restore your company with exceed emission allowances in the next commitment period 2008-2012?

1. We have already participate in such projects

Please specify below

2. Yes we intend.

Please specify below

3. No we do not intend

Please specify below

4. We don’t know yet

QUESTION 16

How you intend to cover additional costs (environmental costs) to purchase emission allowances?

1. We will shoulder the additional cost
2. We will increase the prices of our products
3. We will decrease the productivity cost. Please specify below
4. We do not have any plan of action yet.
5. Other. Please specify below

QUESTION 17

Considering having the opportunity to change the Nap, which is your recommendation?

1. To change of the initial allocation of emission allowances
2. To give more incentives for the development of environmental friendly technologies
3. Other

Please specify below

NAME OF COMPANY:

FULL NAME:

POSITION IN THE COMPANY:

TELEPHONE OF COMMUNICATION:

FAX:

Email:

COMMENTS:

Appendix 6: Questionnaire Results

Question	Answer 1	Answer 2	Answer 3	Answer 4	Answer 5
1	9	1	0	-	-
2	5	3	2	-	-
3	2	4	2	2	-
4	2	1	3	1	3
5	0	4	3	-	-
6	0	7	3	-	-
7	2	0	0	7	1
8	5	3	2	0	-
9	5	5	-	-	-
10	1	3	0	2	4
11	4	4	0	2	-
12	1	3	3	3	-
13	2	5	3	-	-
14	3	7	-	-	-
15	1	2	3	4	-
16	6	2	1	1	0
17	4	6	0	-	-