Sectoral and regional impacts of the European Carbon Market in Portugal

Margarita Robaina Alves
GOVCOPP and Department of Economics, Management and Industrial Engineering, University of Aveiro
Campus Universitário de Santiago, 3810-193 Aveiro, Portugal
Email: mrobaina@ua.pt

Miguel Rodríguez
Department of Applied Economics, University of Vigo
Facultade Empresariais e Turismo, 32004 Ourense, Spain
Email: miguel.r@uvigo.es
url: webs.uvigo.es/miguel.r/ and www.rede.uvigo.es
Corresponding author: tlf & fax: +34986812505

Catarina Roseta-Palma
Department of Economics and UNIDE, ISCTE-Lisbon University Institute
Av. Forças Armadas, 1629-026 Lisboa, Portugal
Email: catarina.roseta@iscte.pt

Abstract Max 200 words

Across Europe, CO_2 emission allowances represent one of the main policy instruments to comply with the goals of the Kyoto Protocol. In this paper we use microdata to address two issues regarding the impact of the European Carbon Market (EU ETS). First, we analyse the sectoral effects of the EU ETS in Portugal. The goal is to study the distributive consequences of imbalances, with the novelty of taking into account firm financial data to put values into context. We show that a large majority of installations in most sectors had surpluses and the opportunity to raise remarkable revenues in some cases. We also look at the regional impact, since the pre-existing specialization of different regions in the production of different goods and services might lead to an uneven economic impact of the allowance market. In particular, Portuguese data indicate a distribution of revenue from low income to high income regions, or rather, between installations located in those regions. We focus on the first Phase of the EU ETS, using data for each one of the 244 Portuguese installations in the market as well as financial data for 80% of these installations, although we also present data for 2008 and 2009.

Keywords: Regional impact, sectoral impact, tradable CO_2 allowances, European Carbon Market
JEL: Q48, Q52,R38

1. Introduction

In accordance with the Kyoto Protocol, signed in 1997, the European Union has pledged to reduce the emissions of greenhouse gases (GHG). The European Union Emission Trading System (EU ETS) was established to that effect by Directive 2003/87/CE. An emission allowance system is a pollution-control instrument based on requiring pollution sources to hold transferable allowances. The regulator issues the desired number of allowances and each source designs its own compliance strategy, including sale or purchase of allowances and pollution abatement. The incentives created by this system ensure that each source has enough flexibility to minimize its compliance costs and, as a consequence, the policymaker's environmental goals are achieved cost-effectively, i.e. at the lowest possible cost for the whole economy.

In spite of the desirable theoretical properties of emission allowance schemes, the nature of the EU ETS raises a few efficiency and equity concerns. Cost-effectiveness of any environmental regulation requires a full coverage of emitters, especially when non-subject sectors present lower abatement costs (see Böhringer et al, 2006). Also, any unequal treatment of sectors generates distributional consequences. For instance, Kettner et al (2008, 2010) show that the power and heat sector has been the only net allowance buyer and discuss whether allocations have favoured large installations relative to smaller ones. In defence of the EU ETS design, a market limited to main emitters is appealing due to a reduction of administrative and compliance costs. Furthermore, there is no evidence of market power, which if it existed would diminish trading efficiency (Convery and Redmond, 2007). For a more complete discussion, Convery (2009) reviews the literature on emissions trading in Europe.

Another problem is associated with the free allocation of pollution allowances by most governments, despite the empirical evidence on the superiority of auctioning. In the EU ETS, governments could auction up to 5% of allowances in phase I (2005-2007) and up to 10% in phase II (2008-2012). In phase I, only four out of 25 Member States used auctions at all, and in only one case were auctions fully employed to the 5% limit (see Hepburn et al (2006) and Ellerman and Buchner (2007)). Cramton and Kerr (2002) note that auctioning "allows reduced tax distortions, provides more flexibility in distribution of costs, provides greater incentives for innovation, and reduces the need for politically contentious arguments over the allocation of rents." This is in line with the conclusions of the literature on revenue recycling through distortionary tax reduction (Parry et al. 1999; Fullerton and Metcalf 2001). Environmental instruments aim to correct pre-existing market distortions. Therefore, when they are used to raise revenue (such as with environmental taxes or auctioned allowances), other taxes which carry deadweight losses (such as labour or income taxes) can be reduced. This type of "green" fiscal reform could thus allow a reduction of the total tax burden in the economy.

Additionally, since climate is affected by the global stock of GHG, the possibility that emissions rise outside the EU because of its stricter policy (i.e. carbon leakage) can seriously hamper the environmental effectiveness of EU efforts. The problem is more acute for tradable sectors that are GHG-intensive, such as iron and steel or cement. However, Reinaud (2008) concludes that there is no significant evidence for carbon leakage due to the EU ETS in the first three years of the scheme. Likewise, EC (2010) states that the expected ETS-related reductions in production for covered industries to 2020 are very small, albeit this is partly due to the favourable treatment such industries have received.

A final point is that regulation falls on installations that in turn are anchored in a physical territory. The EU ETS does not have an explicit regional dimension, which is understandable given the global nature of the GHG problem. Nonetheless, the specialization of the different regions in the production of different goods and services can lead to different economic impacts of the carbon market from a regional point of view. If there is no proportionality between the regional share of affected installations and population, value added or employment, we can expect important distributional effects between regions, even within countries. The European Commission recognizes the importance of enhancing emission reduction without jeopardizing growth in different areas of Europe, and refers cohesion policy, which has a strong regional focus, as an important instrument in this regard (EC, 2010). Hence it is important to study both the sectoral and regional impact of the EU ETS. There is some research on the distributional consequences of financial flows among countries and firms as a consequence of the EU ETS (see for instance Kettner at al 2010, Trotignon and Delbosc, 2008 and the references therein). However, there is usually no data providing economic context of such flows and little attention has been paid to the regional impacts inside countries in the literature, with the exception of Spain (Rodriguez and del Rio, 2008).

The contribution of this paper is to focus on the Portuguese case, analysing in detail both regional and sectoral EU ETS economic impacts. To this end we use data from 2005 to 2009 for Portuguese installations covered by the EU ETS. More important, the main novelty of this piece of research is to conduct the analysis by pooling together data from the Community Transaction Log data base and installations financial data from the "Iberian Balance Sheet Analysis System" (SABI) database for the first four years (it is created and produced jointly by INFORMA D&B and Bureau Van Dijk). The regions are shown according to the European NUTS III classification, consisting of 28 regions in continental Portugal and the Autonomous Regions of Madeira and Azores.

The data reveal that: (i) Portuguese carbon emissions allowances are extremely concentrated in a small number of installations; (ii) the thermoelectric sector was the only one that had significant negative balances; (iii) other sectors appear to have benefited from EU ETS participation, some significantly so; iv) a limited number of regions account for most regulated emissions. Those results, together with the fact that about 60% of national emissions remain unregulated by the EU ETS, highlight the necessity of considering the full distributive impacts when analysing policy measures.

The article is made up of seven sections, including this introduction. Section 2 describes the European Union's Emission Trading System, whereas Section 3 focuses on the first Portuguese National Allocation Plan (NAP). Sections 4 and 5 analyze the sectoral and regional effects of the EU ETS in Portugal, respectively. The second Portuguese NAP is described in Section 6, where data for 2008 and 2009 is presented and some policy discussion is provided. The main conclusions are set out in section 7.

2. The European Union Emission Trading System

The EU ETS is based on six fundamental principles: i) it is a "cap-and-trade" system (an overall cap is set, defining the maximum amount of emissions, and sources can buy or sell allowances on the open market at European level); ii) it is focused on CO_2 from large industrial emitters; iii) implementation is taking place in two phases (2005-2007 and 2008-2012) with periodic reviews; iv) emission allowances are decided within national allocation plans; v) it includes a strong compliance framework; vi) the market is EU-wide but taps emission reduction opportunities in the rest of the world through the use of the Clean Development Mechanism and Joint Implementation, and it also provides links with compatible systems in third countries.

The installations covered by the EU ETS initially received allowances, named European Union Allowances (EUA), for free from each EU Member State's government, in what is known as "grandfathering". However, since unused allowances can be sold, installations are stimulated to invest in emissions reduction even when they are under their "cap" (the grandfathered allowances).

Until recently, each Member State was able to decide the sum of allowances to attribute to the installations regulated by the Directive, following criteria provided by the European Commission. In the two initial phases, a limited number of sectors was included: energy activities; iron and steel; mineral industries (cement, glass, ceramic products); and pulp and paper. It should be noted that the emissions of the installations covered by the market represent approximately 40% of the total CO_2 EU emissions.

In April 2009, the new energy-climate package was approved[1]. This includes a revision of the EU ETS (Directive 2009/29/EC) which contemplates: (i) an EU-wide target for GHG industrial emissions to achieve a 21% decrease in 2020 compared to 2005 emissions; (ii) an extension of the EU ETS to include two other GHG, nitrous oxide and perfluorocarbons, and to cover other sectors, namely aviation and the petrochemical, ammonia and aluminium sectors; (iii) a greater share (above 50 %) of auctioned allowances, albeit differentiated among sectors; (iv) an opt-out possibility for small installations, emitting below 25 000 ton CO_2/year, which show alternative reduction measures. These changes will enter into force in January 2013. The package also contains other provisions, such as national binding targets for renewable-energy use and for non-ETS sectors, in order to reach, respectively, a share of renewables in final energy demand of 20% and an average reduction of 10% in these sectors' GHG emissions, by 2020.

In the first year of trading, which was 2005, 362 Mt (million tonnes) of CO_2 were traded on the market for a sum of €7,2 billion, as well as a large number of futures and options (Point Carbon (2006)). The price of allowances increased more or less steadily to its peak level, in April 2006, of about €30 per tonne CO_2, but fell in May 2006 to under €10 on news that overall emission caps were so generous that in many countries there was no need to reduce emissions. The trading price collapsed in 2007, reaching €0,10 in September of that year. Verified emissions, on the other hand, grew in the first phase of the scheme, albeit by less than GDP. For the countries for which data is available (all 27 member states except Romania, Bulgaria and Malta), emissions increased by 1,9% between 2005 and 2007 (European Commission, 2008).

Phase I is widely believed to have been over allocated. Kettner et al (2010) show that the market was long overall, as the number of allowances was 3.2% higher than actual emissions. Note that countries are said to be short (long) if they had emissions greater (smaller) than their allocation so that they are potential buyers (sellers) of allowances from (to) other countries, in order to achieve compliance. The same terminology can be used for sectors. Only 5 countries were in a short position in Phase I, which could imply that few additional overall emission reductions have been achieved. However, Ellerman and Buchner (2008) emphasize that simply comparing emissions with the cap does not take into account abatement brought about by ETS participation. In their analysis, they compare actual emissions with business-as-usual scenarios to show that abatement might actually explain a significant part of the overall Phase I surplus. At any rate, caps for the second trading period have been lowered 9,5% for the EU as a whole.

[1] See http://ec.europa.eu/environment/climat/climate_action.htm

Ellerman and Buchner (2007) discuss the disparities among countries for 2005, presenting the gross positions for each one as well as the net ones. Kettner et al (2010) provide a similar analysis for the three years of the first period. Both papers note that the member states which comprise a large part of the potential demand are also important suppliers, indicating that many trades were among installations within each country. They also provide a brief sectoral analysis. It is clear that for the EU as a whole, the Power & Heat sector was the only one to have a short position, while the other industrial sectors were all long, often by large percentages (around 20% for Ceramic, Iron, Steel & Coke, and Pulp & Paper). The underlying reasons for this uneven distribution of allowances among sectors appear to have been: the fear of loss of competitiveness for GHG-intensive tradable sectors, carbon leakage and also the cheaper abatement options available to the power sector. As a result, the National Allocation Plans were generous in the number of allowances allocated except for the Power & Heat sector. Unsurprisingly, this sector, which makes up around 60% of EU ETS emissions, represented in 2005 nearly 90% of potential allowance demand. It also accounted for some 50% of the potential supply, thus justifying most of the market's activity.

3. The first Portuguese National Allocation Plan

The target established by the Directive for Portugal is that during the Kyoto compliance period, 2008-2012, mean emissions cannot exceed a 27% increase over the emission levels of 1990. Figure 1 illustrates the actual evolution of emissions until 2008 and the linear path to achieving the target in 2010, excluding land use change and forestry (LULUCF). A reference scenario produced in 2006 placed Portugal 12% above the attributed limit and proposed additional measures aimed at sectors that do not participate in the EU ETS, such as transportation, agriculture, commerce and households. However, the latest official estimates predict the country will be 2% (7,7 Mt CO2e) above the target, and the difference will be covered using the Kyoto Protocol mechanisms of flexibility.[2] Emissions show significant annual variability, mainly due to the fluctuations in hydroelectric power generation that are caused primarily by precipitation variability, as discussed in Section 4.

[insert Figure 1 here]

The first Portuguese National Allocation Plan (NAP), covering the period 2005-2007, considered 38,9 Mt of CO_2 per year, of which 36,9 Mt for 244 industrial installations and the remainder left aside for new installations. Mostly, historical emissions were used to distribute allowances between sectors and installations. Exceptions were made for new installations and for the sectors of electricity generation and iron and steel, where historical data was seen as inappropriate considering technological potential for emission reduction. Moreover, as in most other EU countries, benchmarking was not used (see Ellerman and Buchner, 2007).

The actual distribution of allowances among the 244 installations covered by the EU ETS was based specifically on two criteria: (i) the historical emissions of each one, which had previously been used for the definition of the total allowances assigned to each sector and (ii) combustion emissions assuming an

[2] See http://www.cumprirquioto.pt

“average fuel” for each activity sector. Individual assignments were given out based on the sum of adjusted combustion emissions with historical emissions. Finally, this sum was multiplied by a factor of global adjustment (equivalent to that used for the calculation of the emissions for each sector).

An undeniable characteristic of the first Portuguese NAP was the inclusion of a large number of small installations. Figure 2 ranks the 244 Portuguese installations according to their allocated emissions and reveals the extreme inequality of their size. We can highlight from the allowance allocation that 10% of installations have 90% of emissions allowances. Also, two installations jointly have 31.5% of allowances, and there are 163 installations classified as small (less than 25 000 tons of CO_2), which together account for less than 4% of emissions. Portuguese allowances are thus extremely concentrated. This is similar to findings for all EU countries, where Kettner et al (2008) find that the biggest 1,8% of installations account for 50% of emissions. Naturally, regions where these are located will bear a large percentage of the emission reduction effort.

[insert Figure 2 here]

4. Sectoral effects of the European Carbon Market in Portugal

Based on the final reports of the EU ETS for the years 2005, 2006 and 2007, we can identify sectors that were short and long and assess the potential monetary flows from allowance purchases or sales. Unfortunately this ex-post analysis does not provide any insight into the drivers of actual emissions for the firms. In particular, for “long” installations we do not have any information on abatement efforts nor on the associated costs, which would allow a fuller view of the net result of market participation.

Recall that the Portuguese NAP attributed the equivalent of 36,9 Mt of CO_2 for each year in the first period. Along the period Portuguese installations had a surplus that could have provided revenues of approximately 10,4 M€, 58,8 M€ and 7,5 M€ for all installations. Table 1 shows the sectoral breakdown in terms of emissions (a) and possible monetary flows (b). Positive values indicate potential income from allowance sales and not actual revenues, as it is unlikely that all surplus allowances were actually sold. Moreover, even if they had been, the net economic position from EU ETS participation would need to take into account transaction costs, which tend to be higher for smaller firms, and the abatement cost incurred, if any. Still, ETS data indicates that, in the first phase, fewer than 10% of Portuguese EUA expired worthless (Trotignon and Ellerman, 2008).

[insert Table 1a & 1b here]

Thermoelectric plants have a negative balance in 2005, that is, they discharged more emissions than the allowances allocated to them (approximately one million tons of CO2 in excess). The assigned allowances in that year covered 96% of emissions, mainly due to a drought that reduced hydroelectricity generation, as discussed in section 4.1. There was also a small deficit for Glass in 2007. In the remaining sectors there was a surplus of emission allowances for all years, especially so for Ceramic, Iron and Steel, Other Combustion Facilities and Cogeneration. For comparison, at a European level, the sectors with larger surpluses were Pulp and Paper, Iron and Steel and Ceramics (Kettner et al 2010). We provide some analysis on the significance for each sector of the potential extra revenues and costs below.

One important advantage of microdata is that we can perform a detailed analysis of the potential outcome of the carbon market, with data for each installation. Figure 3 shows the wide discrepancies in the net positions held by different installations. Obviously, these discrepancies reflect the interaction between allowance allocation, abatement activities, and general activity level. The right-hand tail in this figure, with positive 100% positions, refers to installations that had zero carbon emissions despite having positive allowance allocations. On the other hand, those with negative 100% positions represent installations that had to cover double their initial allocations[3]. In 2005 and 2006 around 20% of installations were short and 80% long. Nonetheless, the figure shows that there was a slight shift to the left side accounting to more positive positions in 2006. On the contrary, in 2007 there was a slight shift to the right plus a slight rotation in such a way that a few more installations were short but those that were long were more so. For the same period, in the EU around 27% of installations were short (Kettner et al 2008).

[insert Figure 3 here]

In order to assess the economic implications of these positions for each sector's installations, we use the SABI database. It contains general information and, more important for our purposes, the financial accounts, for a large number of Iberian firms. We were able to get financial data for 80% of the EU ETS installations, representing approximately 59% of emissions for 2005 and 2006 (about 62% for 2007). The representativeness is even grater (in most sectors close to 100%) if we exclude from calculations Thermoelectric Generation (coverage for this sector is around 34%). Table A2 in the Appendix includes detailed information about the sectoral coverage of emissions for each year. Some interesting conclusions can be presented regarding the possible significance of EU ETS participation in terms of financial accounts. We calculated potential revenue from allowance sales (or cost from allowance purchases) for each installation, using average annual allowance prices as explained in Table 2, as a percentage of that installation's operational revenues. The results are presented in Figure 4 for 2005 and 2006. Results for 2007 are not shown since the low prices made potential ETS flows much lower as compared to costs/revenues. Ceramic is shown separately as it contains a much larger number of installations than other sectors and it has generally higher values (note the difference in scale).

[insert Figure 4 here]

Clearly, some installations may have generated a significant monetary inflow from EU ETS participation, especially in the Ceramic sector where quite a few had the possibility of making allowance sales above 5% of their operational revenues. However, these results should be viewed with caution in light of possible transaction cost burdens, since the Ceramic sector is characterized by a large number of small installations. Again, we do not consider possible abatement costs. Among the other sectors, Cogeneration was the biggest potential beneficiary, with many installations earning an allowance return between 2 and 10% of operational revenues. It should also be noted that the proportion of potential revenues from allowance sales was generally higher in 2005, despite the slightly worse volume positions of firms, shown in Figure 3. The price effect thus seems to have been paramount.

[3] Each year had only one installation (not the same one) with a negative position lower than -100%. These were not included in the figure to minimize scale distortions.

It is interesting to split this type of analysis between big and small emitters. We use as a criterion the Directive 2009/29/EC where installations under 25 000 tons CO2/year are classified as small emitters. Considering all sectors, coverage values tend to be higher for small emitters than for large ones (266% against 142% for 2005-2006 and 199% against 109% for 2007). However, this would be expected given that the sectors that are dominated by large emitters have generally lower levels of coverage (this is true for Thermoelectric, Cement and Lime, Refineries and Glass, although Iron and Steel is an exception), and the one sector that is dominated by small emitters (Ceramics) consistently shows the most favourable coverage values. For those sectors where small and large emitters are both relevant (Cogeneration, Other Combustion Facilities, Pulp and paper), figure 5 presents coverage levels for 2005 to 2007. From the data it is easy to appreciate that surpluses of allowances over emissions are systematically larger for small emitters, even within these sectors. There may be different reasons to explain this result, such as the lack of data to accurately allocate the right number of allowances to smaller emitters, a deliberate over allocation policy in favour of smaller emitters, or more intensive abatement actions by smaller emitters. Nonetheless, such analysis is beyond of the scope of this piece of research.

[insert Figure 5 here]

4.1 Thermoelectric Generation Sector

The thermoelectric generation sector deserves a closer analysis because of the bigger effort required of it, the volume of emissions it produces, and also the variability of emissions it shows in Portugal, depending on the weather patterns that affect hydroelectric production. In Figure 6 we show the net positions for 2005, 2006 and 2007 of the thermoelectric sector, divided into the subsectors of Fuel, Combined Cycle Gas Turbine (CCGT), and Coal. Other subsectors (Biomass and Gasoil) are not shown in the Figure due to their small size.

[insert Figure 6 here]

Overall, in Phase I the Thermoelectric sector had a net surplus of almost 6Mt CO2 (9% of allowances received), but there were relevant differences among years and subsectors. In 2005, the only “long” facilities had been the ones using CCGT. The strong deficit shown by coal facilities and to a lesser extent, fuel facilities, meant that the sector as a whole presented a deficit. On the contrary, in 2006 this sector had a surplus even if coal facilities continued to show a negative balance, whereas all subsectors had surpluses in 2007.

To understand what happened in the period, we need to look at weather factors. The deficit in 2005 can largely be explained by that year’s drought. It should be noted that renewable energy sources in Portugal, of which hydroelectric production is the largest by far (over 60% of installed capacity), normally account for a significant part of electricity consumption (between 20% and 40%). In 2005, that value was only 19,2%, with hydropower generation less than half its average value (the hydraulic index for the year was 0,42, which means meaning that it rained 58% less than in an average hydrologic year). 2006, on the other hand, was an average hydrological year, and hydro production was 124% higher than in 2005. In contrast, 2007 was drier but renewable energy production still increased by 2%, since the slight decrease in hydro was more than offset by the growth in wind power generation. Interestingly, the large sectoral emissions reduction between 2006 and 2007 (12% fewer emissions with only a 3,6% drop in electricity generation) cannot be fully explained by this factor, indicating that there were efficiency gains during the period. [4]

We end this section by noting that wide variations in emissions (hence in allowance transactions) should be expected for the power sector whenever renewable sources, especially hydroelectricity, face large variability. For example, Ellerman and Buchner (2007) note that emissions also fluctuate greatly in Denmark, Sweden and Norway, depending on hydroelectricity production in the two latter countries. The effect may or may not show up in the allowance prices, depending on weather conditions throughout Europe. Although a couple of studies have looked at the effects of weather on allowance prices (Mansanet-Bataller et al (2007), Alberola et al (2008)), they focus on temperatures, which only drive demand, and not precipitation, which may also affect supply.

5. Regional effects of the European carbon market in Portugal

As noted in the Introduction, not much research has looked at the possible impact of EU ETS in regional terms in spite of the dissimilar impacts that can be expected among regions due to their specialization patterns in the production of goods and services. The European Commission recognizes the importance of enhancing emission reduction without jeopardizing growth in different areas of Europe, and refers cohesion policy, which has a strong regional focus, as an important instrument in this regard (EC, 2010). There are 30 NUTS III regions in Portugal, of which 5 have no registered emissions for any year and 13 have very low emission levels, of less than 1% of national emissions. The remaining 12 regions consistently account for around 97% of emissions. Figure 7 shows the relative weight of each one of these 12 regions in terms of emissions, population and Gross Value Added GVA for 2005 (values do not change much for different years).

[insert Figure 7 here]

There are relevant asymmetries in the contribution of each region to the different variables. In particular, we can see that the two largest metropolitan areas (Grande Porto, GP, and Grande Lisboa, GL) have the largest shares of population and GVA, yet account for a smaller share of emissions. Also noticeable are the regions whose relative level of emissions largely exceeds their contribution to the GVA, such as Peninsula de Setúbal (PS), Médio Tejo (MT) and the most evident case, Alentejo Litoral (AL), which contributes with 32,1% to national emissions and only 1.3% to GVA. We can also see (and confirm with Table A1 in the Appendix) that 80% of regulated emissions com from only 5 regions, which together represent 52% of national GVA. As in the sectoral analysis, there is a high concentration of regulated emissions in a limited number of regions which are those where most industry is located.

In Figure 8 we provide an analysis of emissions relative to industrial GVA (including energy and construction) considering average values for 2005-2007. Here we might expect to find a stronger correlation. However, there are significant disparities between regions, even in this case. A simple regression analysis (not shown) between per capita emissions and industrial GVA has very low explanatory power (R^2=0,06 if we exclude Alentejo Litoral, a clear outlier in the data set). DEIXAMOS If we

[4] Data is from http://www.dgge.pt/

recall that the levels of emissions and allocated allowances vary between sectors, and that the largest emitter in the EU ETS is thermoelectric generation, we see that there is a significant correspondence between the regions with the highest level of emissions and the location of thermoelectric plants: this is especially clear for Alentejo Litoral (AL) and Médio Tejo (MT), since the only two Portuguese thermoelectric installations still based on coal are sited there (Sines and Pêgo, respectively). The high level of emissions in these two regions is therefore related with this type of industry and not with general economic activity, or even industrial activity. Unfortunately, we do not have data on GVA for ETS vs. non-ETS sectors in order to provide a finer analysis.

[insert Figure 8 here]

Although regional GVA data includes all economic activity that is physically in each area, it should be noted that not all impacts of financial flows due to EU ETS participation occur necessarily within the same region. In particular, ~~many~~ some installations belong to national and multinational ~~public~~ companies, whose shareholders can be spread among different regions. Using the tax identification numbers given in the SABI database for each installation, we have selected those companies that are present in more than one region and subtracted their emissions from regional totals. For 2005, there are two regions (Alentejo Litoral and Algarve) where “true” regional emissions are below 10% of verified emissions and three regions (Baixo Mondego, Grande Lisboa and Peninsula de Setúbal) where they are below 50%. The largest companies, which account for most of the subtracted emissions, are Grupo EDP (Power sector), Cimpor (Cement) and Petrogal (Refineries) which jointly represent as much as 62% of Portuguese GHG in 2005.

In spite of this qualification, we believe it is instructive to analyse the regional dispersion of EU ETS potential economic impacts. In order to evaluate this, we calculated the net difference between the emission allowances attributed to each region (on the basis of installation location) and the actual emissions for Phase I. A positive value indicates that the sum of installations located in the region received more allowances than they used. The eventual proceeds from selling the surplus may then contribute to increase the regional GVA. Likewise, a negative difference indicates that the installations located in this region had to buy allowances and therefore transferred part of their GVA to other regions. Table 2 summarizes these effects. The last two columns show the allowance deficits (-) and surpluses (+) by region in tons and as a participation over the total Portuguese balance, respectively. The other columns illustrate the regional deficit or surplus by sector.

[insert Table 2 here]

As mentioned in section 4, if we consider the whole of Phase I, all sectors had an allowance surplus. Yet if we do the same analysis by regions, we see that some regions had a deficit and others a surplus, as shown in Figure 9. Particularly, Alentejo Litoral, Minho-Lima and Região Aut. Madeira had deficits of around 2% of the national surplus. Still, most regions have a surplus; the ones with larger surpluses are shown in green, and these are concentrated in the coastal regions between Lisboa and Porto, where most Portuguese wealth is generated. Remarkably, the metropolitan areas (GL and GP), as well as the next most heavily populated area (PS), had very large surpluses (18.7%, 25.2% and 38.4%, respectively). These are already the richest regions in the country.

[insert Figure 9 here]

As in section 4, to determine the economic impacts of the EU ETS on regions we will consider prices of 21,73€, 15,14€ and 1,3€ per ton of CO_2 in 2005, 2006 and 2007, respectively. Table 3 illustrates the regional significance of allowance costs or potential revenues. In the 4 regions that usually present costs (Minho-Lima (M-L), Médio Tejo (MT), Alentejo Litoral (AL) and Região Autónoma da Madeira (RAM)) these are not always very significant. The worst cases are Alentejo Litoral (AL) and Médio Tejo (MT) where the costs of the EU ETS reached for the Phase I 13,78 million and 8,62 million euros respectively. The remaining regions present surpluses, the highest corresponding to the regions of Grande Porto (GP) and Grande Lisboa (GL), with average potential revenues of approximately 26,8, and 20,8 million euros respectively. However there is a large variation in the values as they are strongly correlated with carbon prices which fluctuated substantially along the period. Therefore the 2005-2006 values are perhaps more meaningful for our analysis. By taking the regional industrial GVA we can measure the economic relevance of the EU ETS. Thus the weight of the net allowance value on the industrial GVA for Alentejo Litoral (AL) and Médio Tejo (MT) was in range (-1,28%, -0,24%). Whereas, if we have a look to the top winner we found that is now Península de Setúbal, with a potential +0,93% weight of the net allowance value on the industrial GVA in 2006,. So eventually the EU ETS might have a significant impact for some regions if the carbon price is high enough. And that may be the case in the near future according to more stringent environmental objectives in the EU.

[insert Table 3 here]

Since most of the emission reduction effort in Portugal is concentrated on the thermoelectric sector, there is in territorial terms a distortion on the energy-producing regions, which assume a disproportionate responsibility for emission control. On the other hand, the regions that do not produce energy may still contribute through energy consumption effects. Price pass-through, if allowed, could be a significant distributional factor, but so far that has not been the case because of public restrictions on consumer electricity prices, as discussed in Section 6

Figure 10 shows the different values for consumption and production of electricity at the regional level. Both the total production of electricity and the thermoelectric generation alone are shown. Five regions (PS, MT, Oe, GP and AL) represent 87% of Thermoelectric generation, 75% of electricity generation, and 29% of electricity consumption. Together they account for 80% of the CO2 regulated by the EU ETS and 41% of Portuguese population. The most unequal cases are Alentejo Litoral (AL), with 27% of the national thermal electricity generation and only 2.4% of electricity consumption, and Oeste (Oe), with 16% of thermal electricity generation and only 3% of consumption. On the other hand, we have the opposite situation in Grande Lisboa (GL), which has 18% of electricity consumption and only 0.9% of thermal production.

[insert Figure 10 here]

Considering all sectors of economic activity, we can trace the regional economic implications of the EU ETS more closely. Figure 11 shows the sectoral composition of GVA in Portuguese regions. The division used here considers three groups of sectors: I (agriculture, hunting and forestry, fisheries and aquiculture), II (industry including energy and construction) and III (services). There are no overall regional emissions data available to compare with EU ETS regional emissions. Nonetheless, sectors I and III are largely excluded from emission cap regulations although they account for an important part of national emissions.

Sector III is paramount in Grande Lisboa (GL), Grande Porto (GP) and Península de Setúbal (PS), representing 83%, 73% and 69% of economic activity, respectively. These are also the main population centres, and may therefore be the overall main emitters of non-ETS GHG. If all sectors were covered by emission-reduction schemes, these regions could be expected to show the highest costs (instead of reaping the most potential benefits as in Figure 9).

[insert Figure 11 here]

6. Portuguese Emissions Reductions in 2008 and beyond

In the second Portuguese National Plan (NAP II), covering the period 2008-2012, 152,5 million allowances (CO_2 equivalent tons) were issued, implying an annual value of 30,51 Mt (a decrease of about 17%). Between the first and second NAP there was also a modification in the industries included in the emissions market, in accordance with new EC rules and some national modifications. In Phase II part of the ceramic industry is excluded, and units of cogeneration and combustion facilities of the chemical sector are included. Comparing equivalent installations in both periods, the decrease in attributed allowances is 22,4%. Table 5 shows the sectoral distribution of these reductions.

[insert Table 4 here]

The electricity generation sector will once more have to make the largest reduction effort. This could strengthen the conclusions that we reached for Phase I, namely in terms of the higher damage concentration in the regions where these installations are located. The actual cost will depend on hydrological conditions. Moreover, it should also be mentioned that Portuguese electricity prices are mostly regulated and cannot be freely increased. As the costs of providing electricity have increased (due to many factors, including the EU ETS), and prices have not been raised accordingly, EDP, which is the main electricity provider in the country, was by the end of 2008 burdened with a debt (the so called tarif-deficit “défice tarifário”) of around 2 million euros, to be recovered from consumers, with interest, starting in 2010 (Jornal de Negócios, 2008). The same problem with cost pass-through is noted for Spain, namely by Oberndorfer (2008), which points out that this may be one of the reasons stockmarket values of electricity firms in that country are inversely correlated with permit prices, unlike in other countries. In energy markets without price regulation, on the other hand, results indicate high levels of pass-through, leading to significant windfall profits from EU ETS participation for the power sector (Sijm et al, 2006).

Table 5, like Table 2, presents data for emissions, coverage, and potential allowance revenues or expenses, now considering 2008 and 2009. The only sector that was “short” was, again, thermoelectric generation, while the country’s ETS participation as a whole continues to show a surplus. Nonetheless, it should be noted that for these two intial Phase II years it is highly unlikely that firms have sold a significant part of their allowance surplus, for two reasons: Portugal had, as most other European countries, a recession in 2008-09, so firms may be holding on to allowances while expecting a rebound of economic activity; second, Phase II allowances are bankable, which means they can still be used in 2013 and beyond.

[insert Table 5 here]

Still, if we have a look at the potential allowances sales (purchases) as % of operational revenue in 2008 (Figure 12) we find values similar to those for 2005-06, although a lower variance of results is noticeable, especially for non-ceramic installations. We do not present the results for 2009 because of lack of financial data in the SABI database. Finally, we found again for phase II similar differences between big and small emitters as coverage values tend to be higher for small emitters than for large ones (145% against 136% for 2008 and 167% against 142% for 2009), albeit these differences are lower than for the Phase I.

[insert Figure 12 here]

The analysis performed above shows that Portuguese ETS targets have been, and continue to be, fairly loose. However, the EU climate and energy policy encompasses all sectors, including those outside the ETS. Figure 13 shows the weight of each sector in national emissions. The largest non-ETS sector is Transport, which accounted for 17% of emissions in 1990 and has since grown to 24%, although other non-ETS sectors are also significant.

[insert Figure 13 here]

A few European Directives have aimed at improving the performance of uncovered sectors, namely the European Energy Performance in Buildings Directive (EPBD), the Ecodesign Directive, the Biofuels Directive and the Energy Services Directive. Such measures have uncertain effects, however, and their costs cannot easily be calculated. Moreover, the inclusion of additional regulations such as these reduces flexibility and may increase compliance costs, especially when there is no clear distinction between ETS and non-ETS policies. Two different issues can arise: the inefficiency of unlinked policies for ETS and non-ETS reductions (since marginal abatement costs will not be equal in all sectors) and the inefficiency of multiple policies within each group of sectors.

It is true that a single system of emissions trading may be unsuitable for most of the uncovered sectors, because the transaction costs of registering and monitoring small emitters could be prohibitive. Theoretically, emission taxes would be capable of achieving targets in a cost-effective manner, by making sure marginal abatement costs are equal for all emitters if all sectors were covered. They would, nonetheless, impose much higher costs on emitters than grandfathered allowances, which were chosen as a starting point in EU-overall emission reduction efforts. The same reasoning may be applicable to the full auction of allowances, which may erode the international competitiveness of domestic industries. As noted in MacKenzie et al. (2008), grandfathering allocations resembles the usual distribution of property rights embedded in command and control environmental policies thus providing a "*closer fit to existing regulatory approaches*". Nevertheless, grandfathering based on historical emissions can be seen as a reward to those installations that made low efforts to abate emissions in the past. For further insights about alternative allocation schemes see MacKenzie et al. (2008) and Böhringer and Lange (2005). They analyse the impact and optimality of implementing a dynamic relative performance mechanism for the initial allocation of pollution permits. Accordingly, the revision of the EU ETS, which will enter into force in January 2013, will reinforce the efficiency problems raised in this paragraph as it contemplates a greater share (above 50 %) of auctioned allowances.

As for the second source of inefficiencies, although climate and energy policies often claim several goals, such as energy security, technological innovation, job creation, or local environmental improvements, the

GHG emissions goal is the only one that is clearly defined and well reasoned. As Böhringer et al (2009a) note, excess costs created by additional policies may be treated as the "price tag" for other goals, but these need to be quantifiable and subjected to cost-benefit analysis. These excess costs may be very significant. For instance, Böhringer et al (2009b), indicate that the overall inefficiency could translate into costs that are 100-125% too high by 2020 when compared to costs of reaching the simple emission reductions target.

As a consequence, there is a growing literature on the costs of overlapping policies. The interaction between multiple policies has been surveyed in del Rio (2007) and most recently in Fischer and Preonas (2010). Eichner and Pethig (2010) and Böhringer et al (2008) analyse the interaction between the ETS and energy taxes, while Böhringer and Rosendahl (2010) discuss the simultaneous application of emissions quotas with renewables quotas, and Tol (2009) provides a cost analysis for different schemes of non-ETS reduction. Interestingly, the latter paper finds that Portugal may be one of the few countries where non-ETS allocations may be larger than projected emissions for 2020.

Del Rio (2007) emphasizes that interactions between multiple policies are likely to be context-specific. For Portugal, a recent paper by Simões et al (2008) provides energy and environmental policy scenarios to gauge the impact of different policies on CO_2 marginal abatement costs. Theirs is a partial-equilibrium model of Portuguese energy system which compares abatement costs for different hypothetical values of emission caps, to be achieved in the period 2020-2030. The reference scenario is one where existing policies (such as the ban on nuclear power and the renewable energy goals) continue to be implemented. This scenario is compared to alternative scenarios where emissions reductions are achieved without some of the existing restrictions, ie. with more flexibility. The simulations indicate that the reference scenario has 42-91% higher marginal abatement costs than the scenarios where existing policy restrictions are dropped. It also implies that the full costs of the Portuguese energy system from 2000 to 2030 are 10-13% higher under the current policies than they could be if all reductions were allocated efficiently).

Unfortunately, none of the Simões et al scenarios considers the possibility of emissions trading. Considering the global nature of GHG emissions and the transnational character of the EU ETS, country-specific caps are only the starting point since high-cost users can purchase allowances abroad instead of abating emissions domestically, thus lowering national compliance expenses. Thus, the authors' estimated costs, assuming that specific emission targets have to be achieved within the national energy system, are higher than necessary.

In Portugal, the current recessionary period provides a difficult background for a discussion of costly new policies, whether or not there are theoretical advantages. Nonetheless, existing fuel taxes could be further adjusted to reflect emissions in transport, and electricity prices should be allowed to gradually increase to reflect true power-generating costs. Some existing energy policies, such as a reduced VAT rate for energy or diesel fuel tax reductions, can be classified as environmentally harmful subsidies.[5] These should ideally be removed. Furthermore the European Commission energy strategy "Energy 2020" points that "*the quality of National Energy Efficiency Action Plans, developed by member states since 2008, is disappointing, leaving vast potential untapped*" despites they are generally recognised as the most

[5] Valsecchi et al (2009) define an environmentally harmful subsidy as: "A result of a government action that confers an advantage on consumers or producers, in order to supplement their income or lower their costs, but in doing so, discriminates against sound environmental practices."

economic way of meeting the EU's energy and climate change goals. For instance, houses and buildings produce on average around ¼ of national GHG in the EU.

Ad-hoc partial targets (such as those for renewable power generation, energy efficiency and so on), existing or future, should be evaluated taking into account EU ETS carbon prices, allowing their cost-effectiveness to be clearly assessed. This type of economic analysis was not performed to evaluate the National Program for Climate Change (PNAC)[6] nor is it performed in the recent National Action Plan for Renewable Energy (PNAER)[7], which lists a large number of policies, many of which are precisely ad-hoc targets. PNAER contains the mandatory estimates for quantitative policy impacts, but no cost assessment. Finally, our own results also indicate an additional problem that may come about due to strict renewable energy targets, namely because hydroelectricity (as well as, to a lesser extent, wind power) can show significant variability, so that reliance on such energy sources may bring large, and possibly undesirable, fluctuations in compliance costs. This kind of problems could be removed for instance with further infrastructure investments in order to increase electricity grid connections through the EU. Besides that could contribute to solve some concerns raised by the European Commission energy strategy "Energy 2020" as it explains that "*the market is still largely fragmented into national markets with numerous barriers to open and fair competition*",

7. Conclusions

This work provides an analysis of the consequences of the EU ETS for Portugal at the sectoral and regional, the last one representing a novelty in the literature. We used data on allocated and verified emissions for all regulated installations for 2005 through 2009. We provide also, and that is one the main contribution of this paper, economic data (aggregate and firm-level), when available, to provide context and relevance by pooling together data from the Community Transaction Log data base and regional and installations financial data. The country as a whole has been long, ie. it has received more allowances than the emissions its industries produced, for every year since the EU ETS started operating, but the distribution between sectors and regions has been uneven.

The first conclusion obtained from the raw emissions data deals with the pronounced inequality of the size distribution of Portuguese installations. Allowances are extremely concentrated in a small number of large installations. For instance, in 2005 50% of emissions came from 1,6% of installations (the four largest ones), which is similar to overall EU values (1,8% of installations account for 50% of emissions, Kettner et al, 2008). Moreover, we show that in Portugal small emitters have generally had better positions, even if sectoral biases are taken into account, while at the European level installation-size allocation disparities are analogous but less clear-cut.

A second conclusion refers to the sectoral effects of the EU ETS, where asymmetries are very pronounced. Only the thermoelectric generation sector has had significant negative balances (in 2005, 2008 and 2009), but even this sector was long in Phase I as a whole. The sectoral bias in the allotment of emissions is also clear at the European level, where the Power & Heat sector stands out for its net short positions in all periods (Kettner 2010). Some possible reasons for this bias are worries about

[6] http://www.apambiente.pt/politicasambiente/AlteracoesClimaticas/PNAC/Paginas/default.aspx
[7] PNAER, preliminary version for public consultation, available in http://www.dgge.pt/, June 2010

competitiveness in tradable sectors and carbon leakage, as well as the apparent availability of cheaper abatement options in the sector. Interestingly, for Portugal the results for thermoelectric generation are seen to be highly dependent on weather conditions, namely precipitation, due to the necessity of replacing hydropower, which accounts for the most significant part of domestic energy production, when hydrological conditions are dry. A final point regarding the thermoelectric sector is that unlike what has happened in many EU countries, price pass-through has not been a significant feature in the strongly-regulated Iberian market.

Still, most installations in all sectors may have gained from EU ETS participation, with firms in sectors like ceramic and cogeneration showing considerable potential for additional revenues. Taking firm-level financial data into account, possible allowance sales are above 5% of operational revenues in most of the installations in these two sectors, and a few reach values above 20%. These results, however, need to be viewed with caution for various reasons. First of all, these sectors encompass many small installations, for which transaction costs can be a serious drain on resources. Secondly, low verified emissions can be a result of abatement efforts, entailing costs for firms that would need to be evaluated against possible allowance sales income. Thirdly, there is a clear difference between long and short positions: while the latter imply that firms need to buy additional allowances to make up for their deficit, the former are not necessarily brought to market. This is especially true for 2008 and 2009 data, as unsold allowances can be used in latter years.

A third set of conclusions deals with the regional impact. As expected, there is a high concentration of regulated emissions in a limited number of regions. Although the EU ETS does not have a specific regional focus, it is still instructive to look at the distributive consequences of participation. We find no obvious relationship between regional emissions and economic data (namely Industry GVA). Regions that house the main thermoelectric installations (in particular, those that have coal-based power production) show the highest asymmetries between emissions and Industry GVA and account for the greatest losses (allowance costs above 1% of Industry GVA for at least one year). We also find evidence for larger EU ETS surpluses in the richer Portuguese regions, where non-ETS sectors account for more of the produced wealth.

Finally, it should be emphasized that the transport sector, agriculture, households and other services are responsible for a large share of emissions but remain unregulated by the EU ETS. We provide a discussion of the literature on overlapping policies, highlighting two different issues: the inefficiency of unlinked policies for ETS and non-ETS reductions (since marginal abatement costs will not be equal in all sectors) and the inefficiency of multiple policies within each group of sectors. And this fact probably reinforces our concerns with the regional distribution of environmental costs. As policy interactions can be very complex, an important recommendation is for context-specific analysis, which indicates a need for more applied research for individual countries.

Future research should focus on a regional-sectoral model of interaction, considering the key sectors, including EU ETS covered and uncovered sectors, or on the use of a General Equilibrium Model for the Portuguese economy that simulates alternative policies. Another important line of work is to provide econometric testing of the relationship between firm-level economic data and emissions (as is done for Germany in Anger and Oberndorfer, 2008; even though they worked with a small sample of firms, only 419)..

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TABLES

Table 1a – Emissions (in Mt) and Attributed Allowance Coverage (%) for 2005, 2006 and 2007.

	2005		2006		2007	
Sectors	**CO_2**	**%**	**CO_2**	**%**	**CO_2**	**%**
Thermoelectric generation	21,91	96	18,67	112	16,42	128
Ceramic	0,87	134	0,81	143	0,88	132
Cement and lime	6,98	102	6,86	104	7,11	100
Cogeneration	2,06	121	2,06	121	2,22	112
Other Comb. Facilities	0,42	127	0,39	135	0,42	128
Iron and steel	0,22	140	0,24	130	0,23	132
Pulp and paper	0,31	115	0,31	117	0,31	115
Refineries	3,01	109	3,02	108	2,94	111
Glass	0,64	106	0,64	104	0,70	98
Total	**36,4**	**101**	**33,0**	**112**	**31,23**	**118**

Table 1b – Potential financial outcome of EU ETS transactions (in Million€) for 2005, 2006 and 2007.

	2005	2006	2007
Sectors	**price 21,73€/ton**	**price 15,14€/ton**	**price 1,3€/ton**
Thermoelectric generation	-20,50	34,85	6,00
Ceramic	6,47	5,24	0,37
Cement and lime	3,32	4,14	0,04
Cogeneration	9,26	6,49	0,36
Other Comb. Facilities	2,42	2,09	0,15
Iron and steel	1,92	1,09	0,10
Pulp and paper	1,05	0,80	0,06
Refineries	5,58	3,75	0,43
Glass	0,89	0,39	-0,02
Total	**10,40**	**58,82**	**7,48**

Source: Own elaboration using the data available in http://ec.europa.eu/environment/ets.
Notes: totals for 2006 exclude 3 installations which were removed, as there were problems with their emissions data. Prices are the weighted average prices of permits traded by European companies, calculated from the monthly average prices and the monthly volume of allowances (tons of CO2) interchanged in the European market, using the data in The European Carbon Market Monthly Bulletin published by Caissê des Dépôts (www.caissedesdepots.fr/missionclimat/).

Table 2 - Deficit (-) or surplus (+) of emission rights in 2005-2007 (t CO_2).

		Thermo-electric generation	Ceramic	Cement and Lime	Cogeneration	Other Combustion facilities	Iron and Steel	Pulp and paper	Refineries	Glass	Total	Total%
North	**Minho-Lima**		23.162		-189.382			4.853			**-161.367**	**-1,60%**
	Cávado		21.519			4.083		9.244			**34.846**	**0,30%**
	Ave				142.657	128.782					**271.439**	**2,70%**
	Grande Porto	2.206.190	19.170		76.350	19.460	66.058	-634	165.439	-23.940	**2.528.093**	**25,20%**
	Tâmega										**0**	**0,00%**
	Entre Douro e Vouga		12.768		5.182	19.520		12.101			**49.571**	**0,50%**
	Douro					-445					**-445**	**0,00%**
	Alto-Trás-os-Montes		14.431								**14.431**	**0,10%**
Central	**Baixo Vouga**		264.980		331.454	55.909		-9.634			**642.709**	**6,40%**
	Baixo Mondego		66.089	-15.291	240.599			80.097		-4.780	**366.714**	**3,70%**
	Pinhal Litoral		90.019	219.736	73.268			-582		83.639	**466.080**	**4,70%**
	Pinhal Interior Norte		94.222		26.803						**121.025**	**1,20%**
	Dão-Lafões	-235	3.843		30.353	15.168		-2.149			**46.980**	**0,50%**
	Pinhal Interior Sul										**0**	**0,00%**
	Serra da Estrela										**0**	**0,00%**
	Beira Interior Norte										**0**	**0,00%**
	Beira interior Sul							-10.724			**-10.724**	**-0,10%**
	Cova da Beira		11.950								**11.950**	**0,10%**
	Oeste		122.192								**122.192**	**1,20%**
	Médio Tejo	-4.581	33.971		16.176			37.641			**83.207**	**0,80%**
Lisbon	**Grande Lisboa**	1.965.217		-156.009	-5.933	71.125		6.509		-3.757	**1.877.152**	**18,70%**
	Península de Setúbal	2.905.071	24.058	417.222	269.240	52.722	168.016	13.477			**3.849.806**	**38,40%**
	Alentejo Litoral	-994.490			126.057				666.409		**-202.024**	**-2,00%**
	Alto Alentejo				-9.797						**-9.797**	**-0,10%**
	Alentejo Central										**0**	**0,00%**
	Baixo Alentejo		7.982		-2.397						**5.585**	**0,10%**
	Lezíria do Tejo		35.386	-26.083	5.944	-9.411		6.596			**12.432**	**0,10%**
	Algarve	-4.306	52.225	13.629							**61.548**	**0,60%**
	Região Aut. Açores	33.619			-12.698	10.091					**31.012**	**0,30%**
	Região Aut. Madeira	-196.939									**-196.939**	**-2,00%**
	Total	**5.909.546**	**897.967**	**453.204**	**1.123.876**	**367.004**	**234.074**	**146.795**	**831.848**	**51.162**	**10.015.476**	**100,00%**

Source: Own elaboration;

Table 3. The potential regional impacts of the EU ETS (values in 1000€ and % of Industry GVA)

		2005 Net Allowance value		**2006 Net Allowance value**		**2007 Net Allowance value**		**2005-2007 Net allowance value**	
	Region	**1000 €**	**% Ind GVA**	**1000 €**	**% Ind GVA**	**1000 €**	**% Ind GVA**	**1000 €**	**% Ind GVA**
North	Minho-Lima	-1.116	-0,17%	-1.172	-0,18%	-49	-0,01%	-2.337	-0,12%
	Grande Porto	6.757	0,16%	18.743	0,43%	1.360	0,03%	26.860	0,21%
Central	Baixo Vouga	4.586	0,25%	4.102	0,22%	268	0,01%	8.956	0,15%
	Baixo Mondego	3.189	0,31%	2.141	0,21%	100	0,01%	5.430	0,17%
	Pinhal Litoral	4.596	0,34%	6.217	0,44%	126	0,01%	10.940	0,26%
	Pinhal Interior Norte	1.023	0,29%	1.046	0,28%	44	0,01%	2.113	0,19%
	Beira Interior Sul	-242	-0,14%	17	0,01%	-1	0,00%	-226	-0,04%
	Médio Tejo	-7.481	-1,01%	-1.915	-0,24%	773	0,09%	-8.623	-0,36%
Lis-bon	Península de Setúbal	-404	-0,02%	20.323	0,93%	2.629	0,11%	22.549	0,35%
Alentejo	Alentejo Litoral	-10.058	-1,28%	-4.896	-0,55%	1.168	0,13%	-13.786	-0,54%
	R. A. Madeira	-1.109	-0,17%	-768	-0,11%	-124	-0,02%	-2.001	-0,10%
	Total Portugal	**-10402**	**-0,03%**	**-51374**	**-0,15%**	**-7542**	**-0,02%**	**-69317**	**-0,07%**

Source: Own elaboration and INE (2006); regions which have no installations, as well as regions where allowances costs are below |0,1%| of Industrial GVA for every year, are excluded from the Table.

Table 4– Comparison of attributed allowances (Mt CO_2) by sectors

Sector /Subsector	**NAP I**	**NAP II (without new entrants 2005/07)**	**NAP II vs NAP I**
Energy Supply	26,8	18,8	-29,7%
Production of electricity	21,0	13,5	-35,5%
Refineries	3,3	3,0	-6,7%
Cogeneration	2,5	2,2	-11,4%
Industry	10,1	9,8	-3,3%
Cement and Lime	7,1	7,0	-1,4%
Ceramic	1,2	1,0	-15,8%
Glass	0,7	0,7	-2,6%
Pulp and Paper	0,4	0,3	-6,9%
Iron and Steel	0,3	0,3	8,4%
Other Combustion facilities	0,5	0,5	-6,5%
Total for existing installations	36,9	28,6	-22,4%
Reserve for new entrants	1,3		
TOTAL	**38,2**		

Source: PNALE II (2008)

Table 5 – Emissions (in Mt), Coverage (%) and Potential financial outcome for 2008 and 2009

.

Sectors	**Emissions 2008**	**Coverage %**	**price 18,56 €/ton**
Thermoelectric generation	15,78	89	-32,93
Ceramic	0,27	211	5,54
Cement and lime	6,78	106	7,91
Cogeneration	2,53	137	17,36
Other Combustion Facilities	0,40	135	2,56
Iron and steel	0,20	164	2,43
Pulp and paper	0,34	114	0,86
Refineries	2,95	110	5,30
Glass	0,66	117	2,02
Total	**29,91**	**102**	**11,06**

Sectors	**Emissions 2009**	**Coverage %**	**price 12,58 €/ton**
Thermoelectric generation	15,80	89	-22,61
Ceramic	0,21	267	4,48
Cement and lime	5,45	132	22,09
Cogeneration	1,80	144	10,06
Other Combustion Facilities	0,31	174	2,88
Iron and steel	0,15	217	2,27
Pulp and paper	0,37	104	0,18
Refineries	2,62	124	7,79
Glass	0,57	135	2,52
Total	**27,28**	**118**	**29,65**

Source: Own elaboration using data available in http://ec.europa.eu/environment/ets.

APPENDIX

Table A1: Regional CO_2 regulated Emissions, GVA and Industrial GVA (2005)

	Portuguese Regions Nuts III		CO_2 (ton)	CO_2 (%)	GVA %	Industrial GVA %
North	Minho-Lima	M-L	182.013	0,5	1,5	1,9
	Cavado	Ca	28.426	0,1	3	4,2
	Ave	Av	253.848	0,7	3,7	6,7
	Grande Porto	GP	3.239.134	9,3	12	12,4
	Tâmega	Ta	0	0	2,9	4,5
	Entre Douro e Vouga	EDV	74.387	0,2	2,2	4,4
	Douro	Do	3.998	0	1,4	0,9
	Alto-Trás-os-Montes	ATM	10.936	0	1,4	1,2
Central	Baixo Vouga	BV	590.515	1,7	3,5	5,5
	Baixo Mondego	BM	2.257.925	6,5	3,3	3,0
	Pinhal Litoral	PL	1.792.759	5,2	2,5	4,0
	Pinhal Interior Norte	PIN	142.624	0,4	0,8	1,0
	Dão-Lafões	D-L	76.735	0,2	1,9	2,3
	Pinhal Interior Sul	PIS	0	0	0,3	0,3
	Serra da Estrela	SE	0	0	0,3	0,2
	Beira Interior Norte	BIN	0	0	0,7	0,6
	Beira interior Sul	BIS	31.220	0,1	0,6	0,5
	Cova da Beira	CB	546	0	0,6	0,6
	Oeste	Oe	96.261	0,3	2,8	3,3
	Médio Tejo	MT	4.122.429	11,9	1,8	2,2
Lisbon	Grande Lisboa	GL	4.796.533	13,8	31,8	20,8
	Península de Setúbal	PS	4.011.021	11,6	5,2	5,8
Alentejo	Alentejo Litoral	AL	11.131.160	32,1	1,3	2,3
	Alto Alentejo	AA	40.307	0,1	1	0,7
	Alentejo Central	AC	0	0	1,4	1,3
	Baixo Alentejo	BA	8.191	0	1	0,9
	Lezíria do Tejo	LT	383.273	1,1	2,1	2,2
	Algarve	Al	517.755	1,5	4,1	2,9
	Região Autónoma dos Açores	RAA	463.588	1,3	2	1,4
	Região Autónoma da Madeira	RAM	458.295	1,3	2,9	1,9
	Portugal		**34.713.872**	**100**	**100**	**100**

Source: Own elaboration using data from INE (2006).

Table A2: Percentage % of emissions covered by the SABI database.

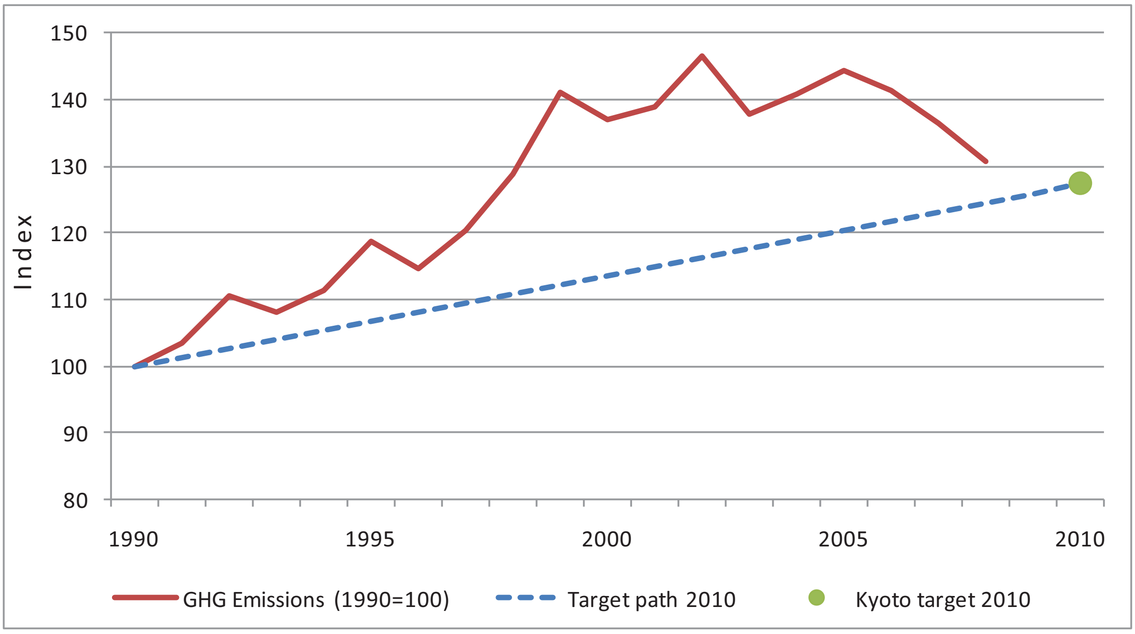
Sector	Coverage 2005	Coverage 2006	Coverage 2007
Thermoelectric generation	34,04%	32,18%	35,74%
Ceramic	85,72%	85,62%	70,93%
Cement and lime	100,00%	100,00%	100,00%
Cogeneration	100,00%	98,32%	78,37%
Other Combustion facilities	60,88%	79,55%	60,48%
Iron and Steel	100,00%	100,00%	100,00%
Pulp and paper	97,56%	97,65%	98,37%
Refineries	100,00%	100,00%	100,00%
Glass	74,23%	96,46%	70,68%
TOTAL	**59,06%**	**58,98%**	**62,60%**

Source: Own elaboration.

Figure(s)

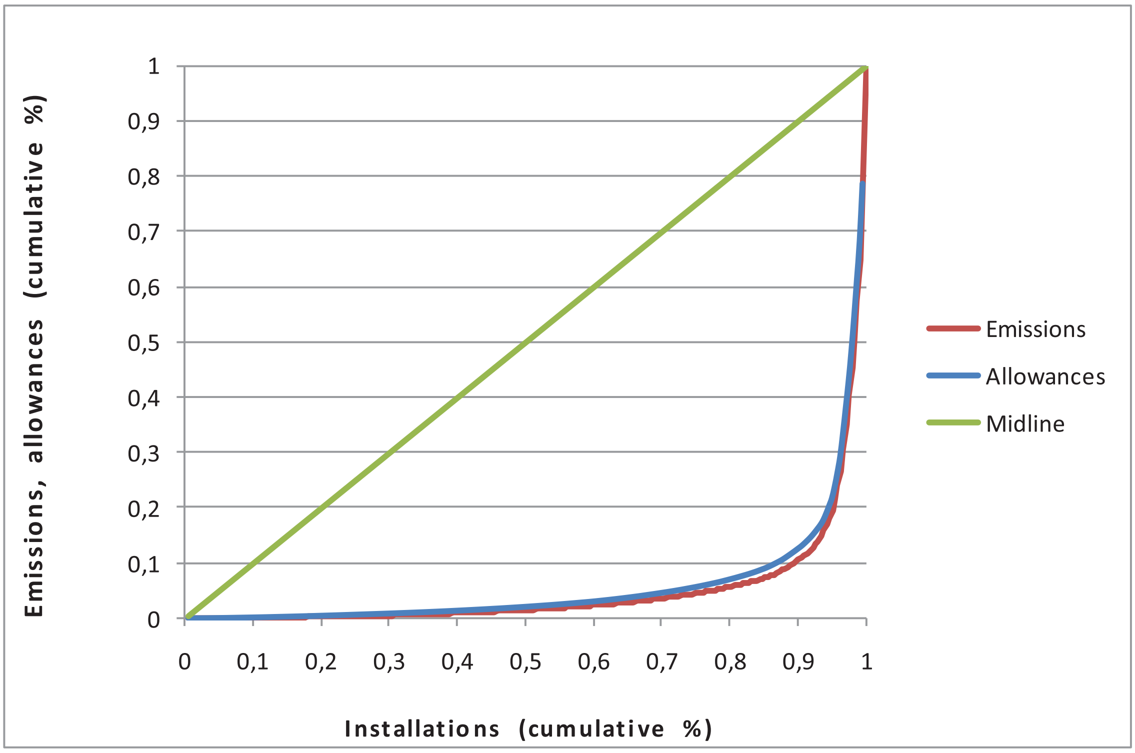
FIGURES

Figure 1: Emissions and linear path to Kyoto target



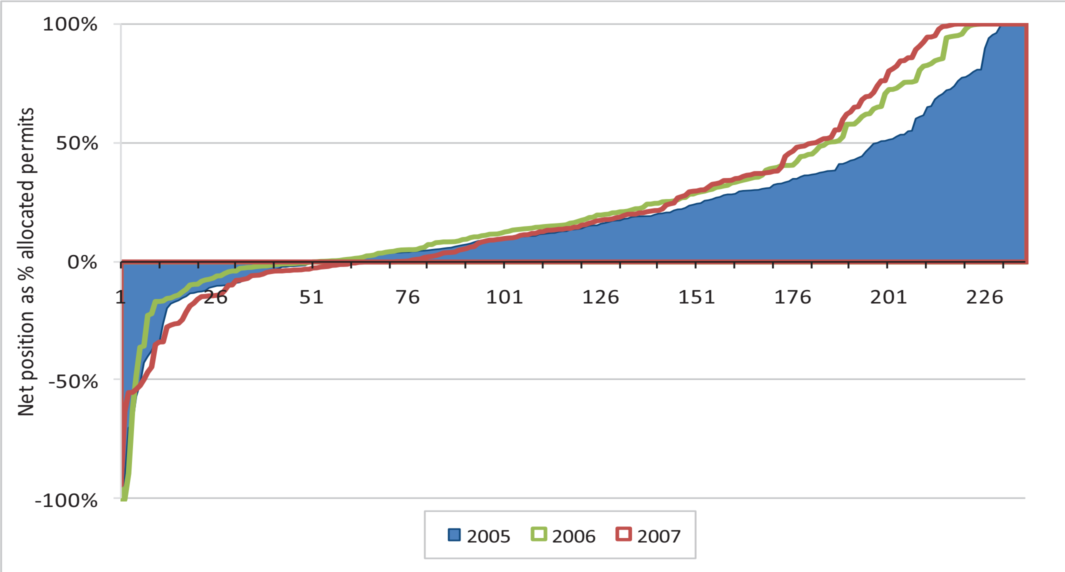
Source: Agência Portuguesa de Ambiente

Figure 2: Inequality in the distribution of emissions and allocated allowances (2005)



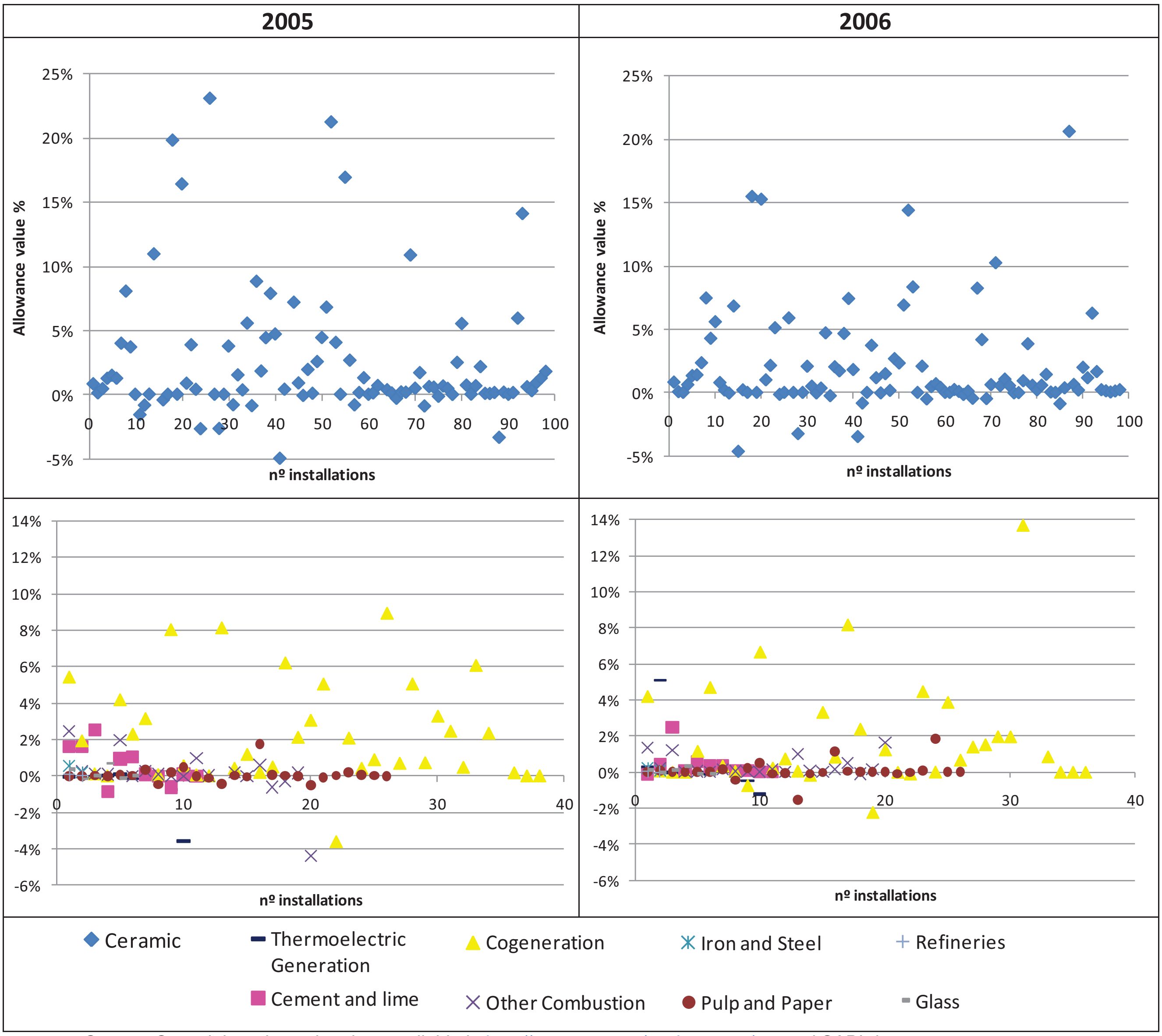
Source: Own elaboration using data available in http://ec.europa.eu/environment/ets

Figure 3: Net position as % of allocated allowances in 2005, 2006 and 2007



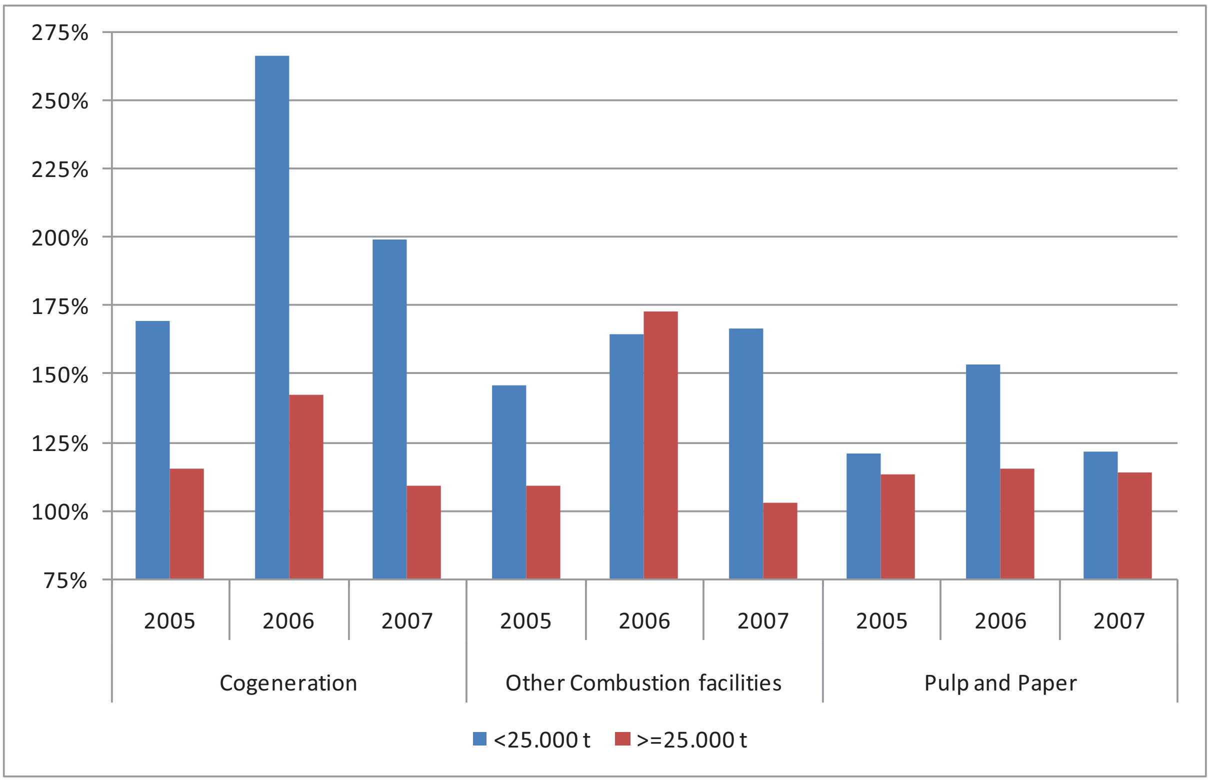
Source: Own elaboration using data available in http://ec.europa.eu/environment/ets

Figure 4: Potential Allowance Sales (Purchases) as % of Operational Revenue in 2005 and 2006 respectively for Ceramic and the other sectors



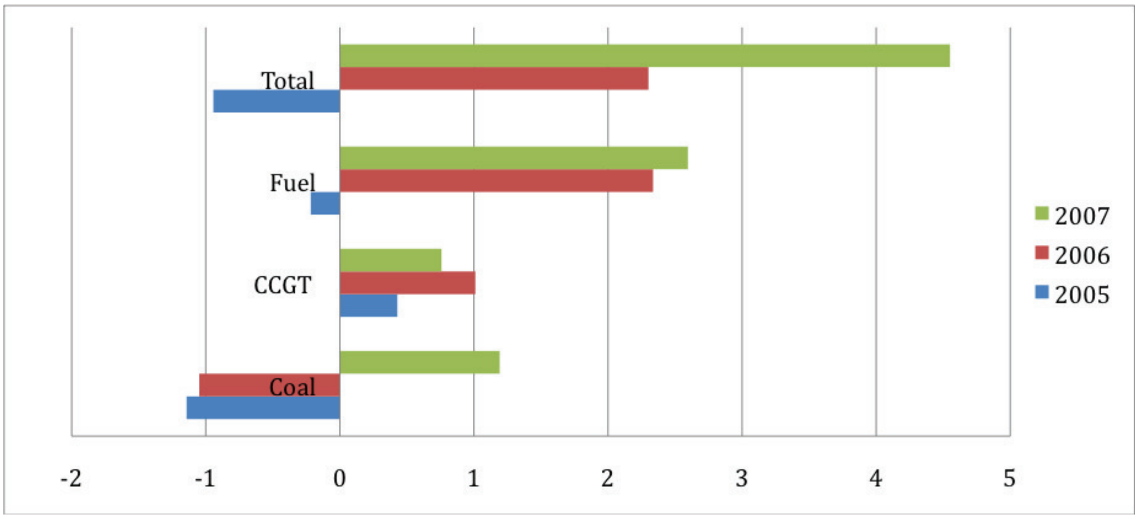
Source: Own elaboration using data available in http://ec.europa.eu/environment/ets and SABI data.
Note: All installations with zero emissions were removed from the sample for this figure, as well as a few outliers (4 with strongly positive permit revenues in 2005 and 1 in 2006).

Figure 5: Allowance coverage for sectors with a mix of sizes, 2005-2007



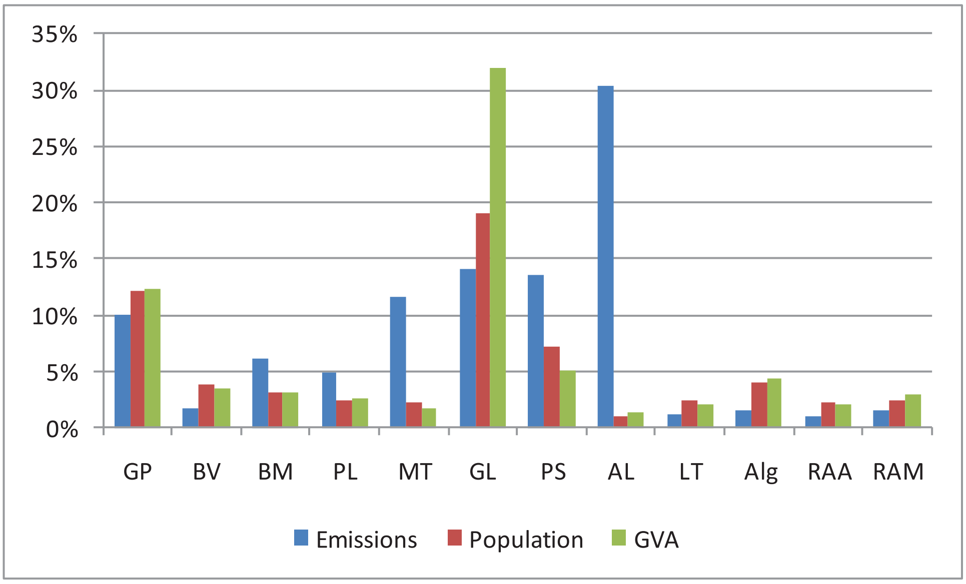
Source: own calculations

Figure 6: Thermoelectric Generation Net Positions (in Mt CO2)



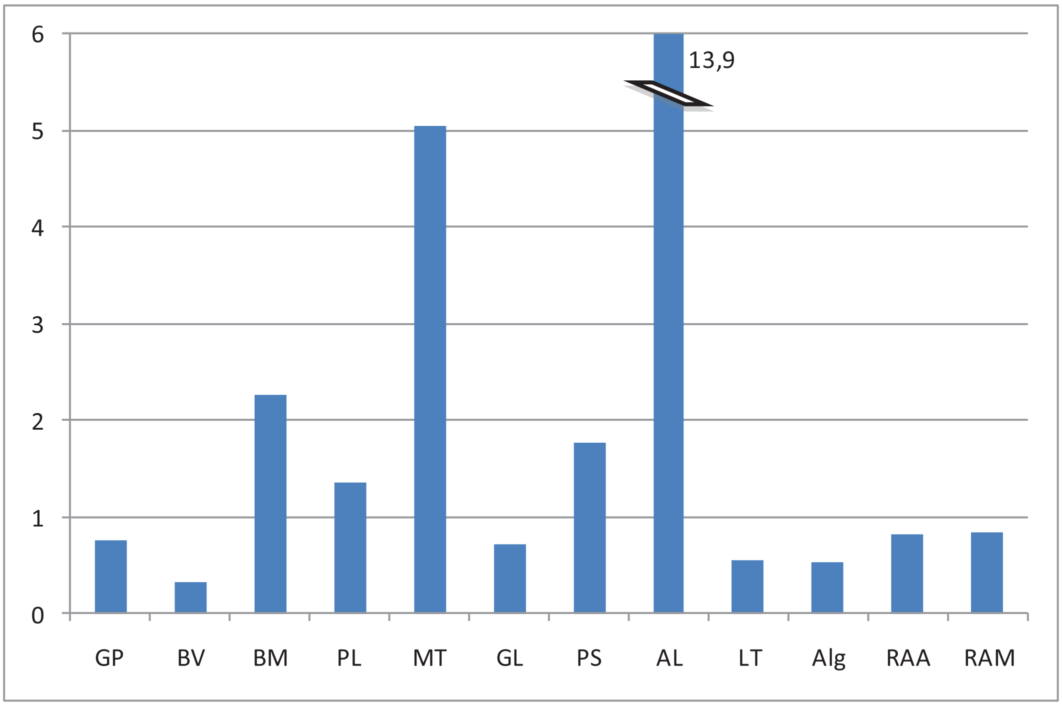
Source: Own elaboration using data from http://www.dgge.pt/

Figure 7: Relative Emissions, Population and GVA (%) in selected regions (2005)



Source: Own elaboration using data available in http://ec.europa.eu/environment/ets and INE (2006) www.ine.pt
Note: See Appendix for full region names

Figure 8: Relative weight of Emissions compared to Industrial GVA by regions in 2005-2007



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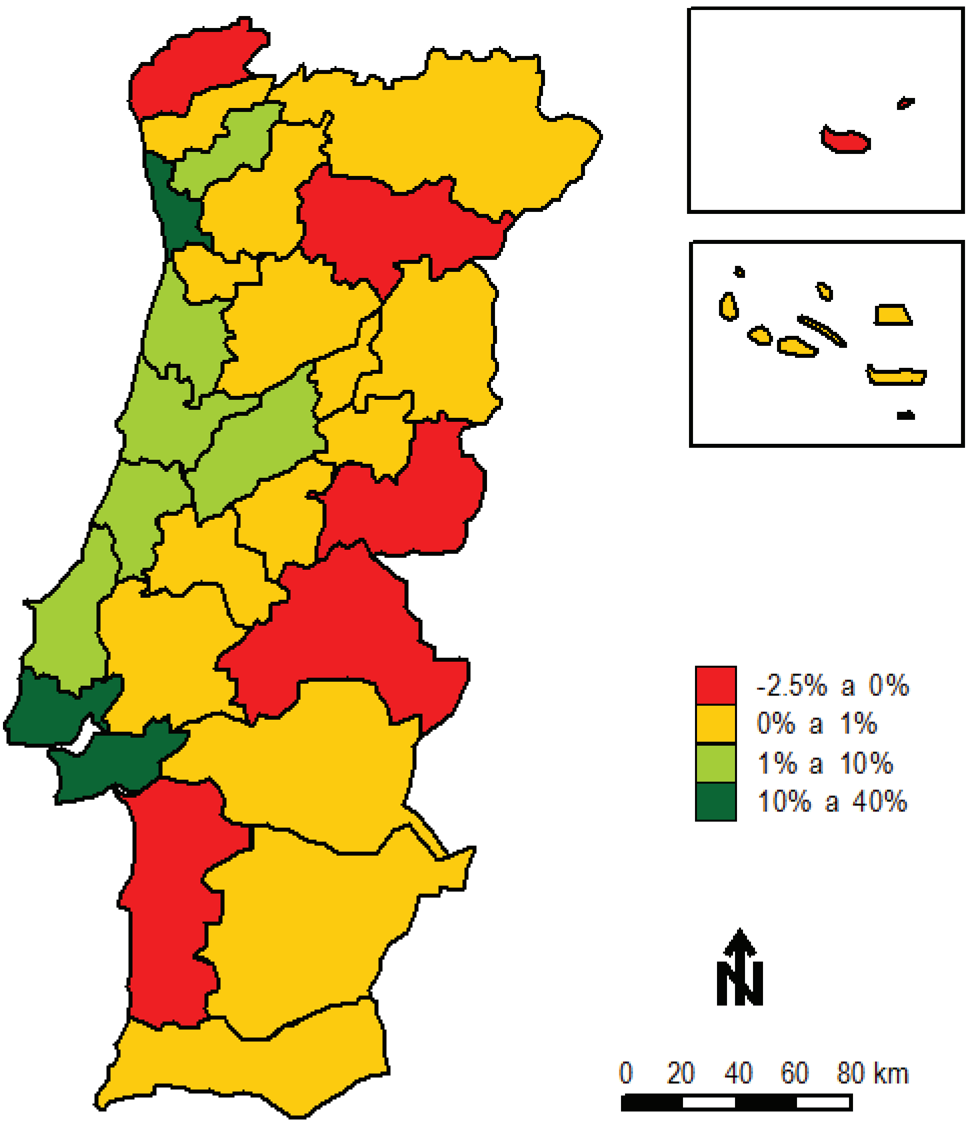
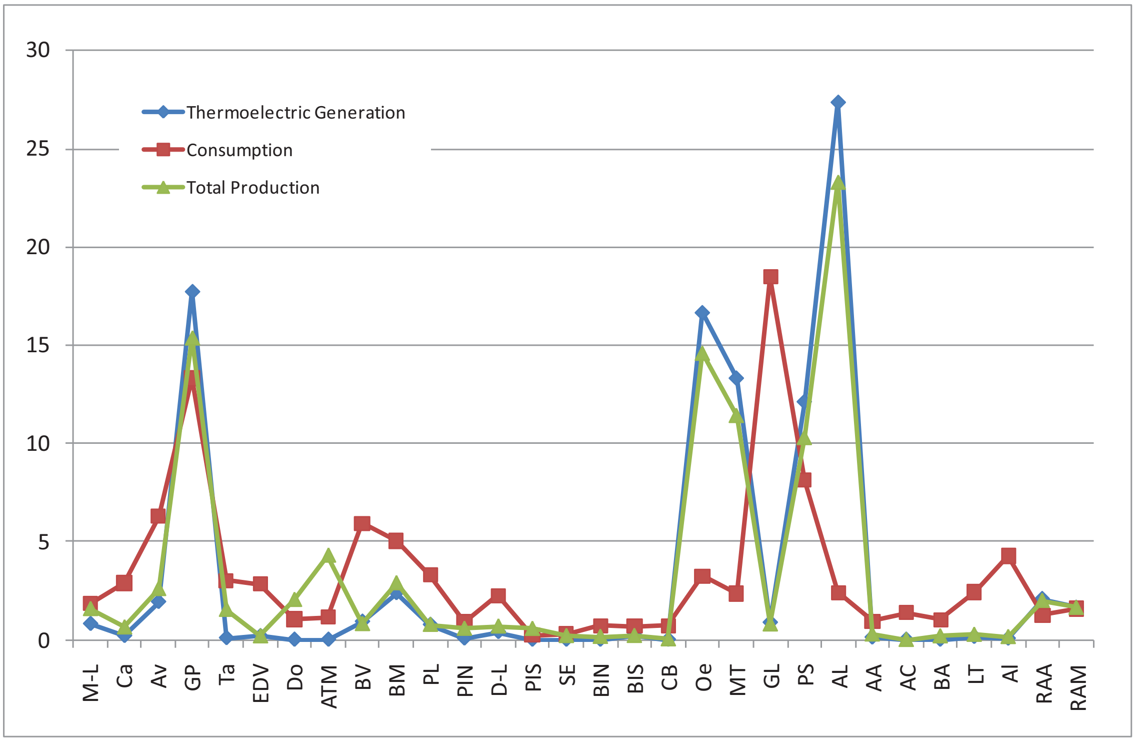
Source: Own elaboration using CO2 data available in http://ec.europa.eu/environment/ets and GVA from INE (2006)

Figure 9. Participation (%) of each region on the Portuguese balance of the EU ETS in 2005-2007



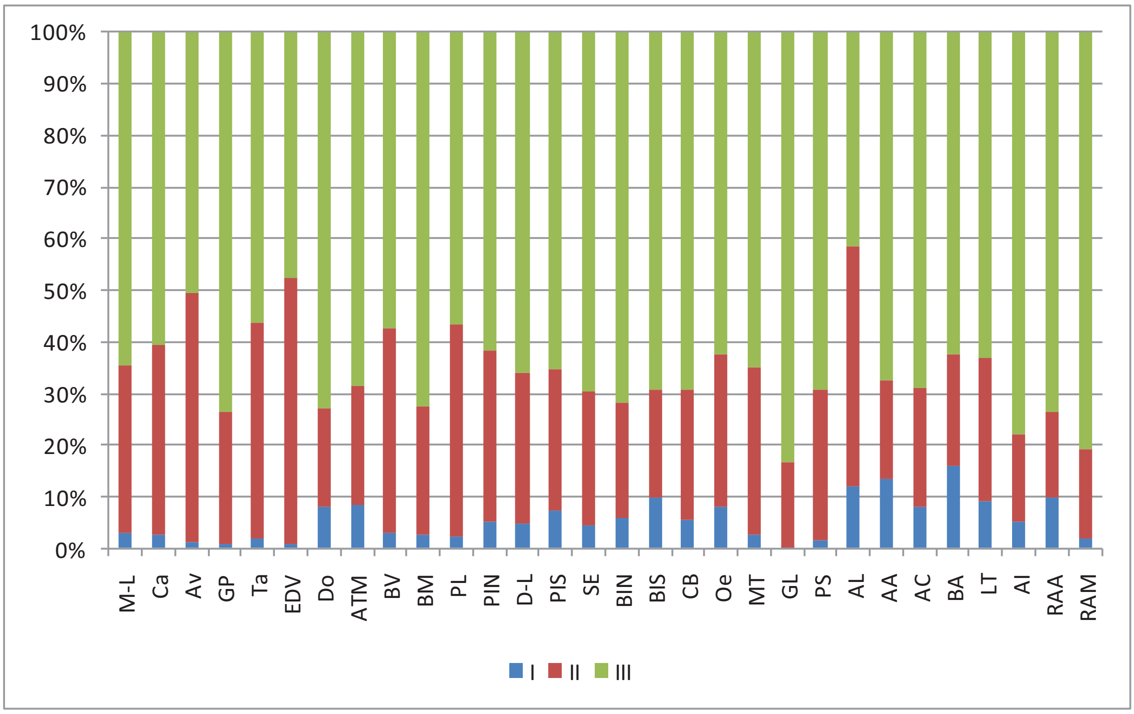
Source: own elaboration from Table 3.

Figure 10. Production and consumption of electricity by regions, as % of national total (2005)



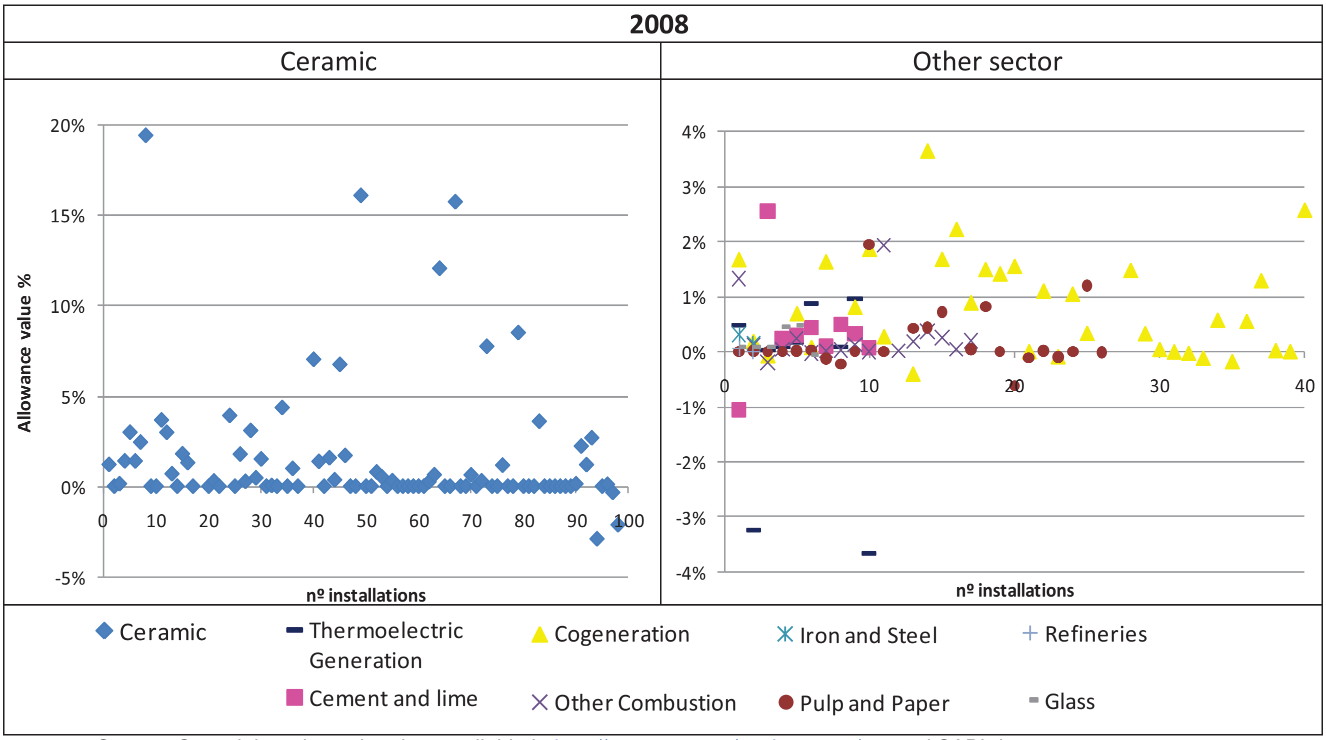
Source: Own elaboration using data from http://www.dgge.pt/

Figure 11. Sectoral composition of 2005 GVA in % for Portuguese regions.



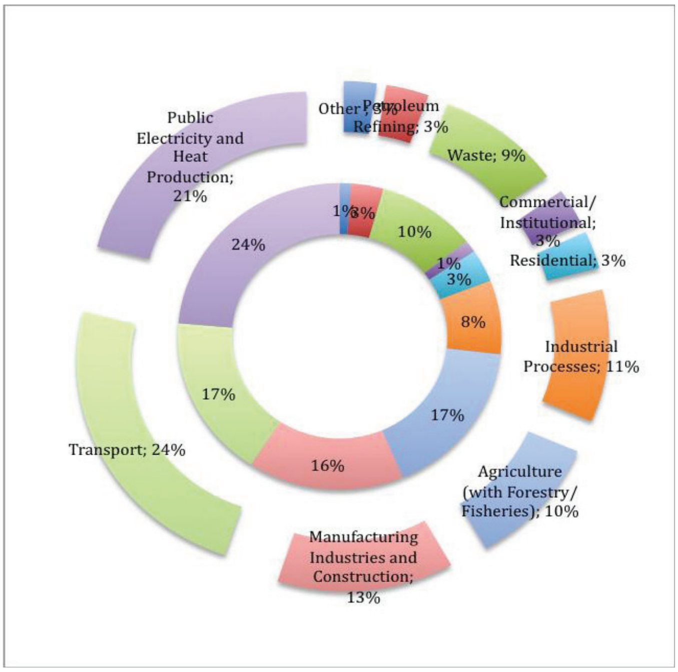
Source: Own elaboration using data available in INE (2006).

Figure 12: Potential Allowance Sales (Purchases) as % of Operational Revenue in 2008 [1]



Source: Own elaboration using data available in http://ec.europa.eu/environment/ets and SABI data.

Figure 13: Sectoral CO_2 emissions (%) in 1990 (inner) and 2007 (outer)



Source: Own elaboration using data available in EEA, http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475

[1] All installations with zero emissions were removed from the sample for this figure, as well as a few outliers (4 with strongly positive permit revenues in 2005 and 1 in 2006).