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Allowance Allocation and CO_2 Intensities in the EU Energy Sectors

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Allowance Allocation and CO_2 Intensities in the EU Energy Sectors.

Sammanfattning/Summary

The objective of the study was to investigate whether the national allocation plans of the EU Member States are fair and reasonable, for the energy sectors. The CO_2 intensities and allocations were investigated for each Member State. The study concludes that there is very little correlation between CO_2 intensity in the energy sector and the generosity of the allocation to the sector in the respective Member States. This indicates that the National Allocation Plans are not fair and reasonable, and that they do not meet all of the Annex III criteria.

Nyckelord samt ev. anknytning till geografiskt område eller näringsgren /Keywords

Emission trading, allocation, EU ETS, climate policy, climate change, energy, CO_2 intensity

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1 Background

In January 2005, the EU Emission Trading Scheme (EU ETS) is due to start. An important part of the process leading up to the start of the ETS is the development and evaluation of the National Allocation Plans (NAP) that each Member State has to submit to the EU Commission. The NAP shall meet a number of criteria, listed in the Directive 2003/87/EC of the European Parliament and of the Council (in this study denoted the "EU ETS directive"). This study is an effort to provide input to the discussion on how the NAPs can be evaluated against the criteria in the EU ETS directive and whether it is possible to determine if the allocation process is "fair", in some sense of the word.

2 Objectives

In a layman's words, we are interested in whether the national allocation plans are fair and reasonable. In order to achieve this, the study was focussed on three main objectives:

1. Compare the CO_2-emissions per GWh generated energy for the EU Member States.

2. Analyse the correlation between the number of allocated allowances/emitted ton of CO_2 and the CO_2 intensities in the respective EU Member States

3. Analyse whether the NAPs submitted to the EU commission meet criteria 3, 7 and 8, as listed in the EU ETS directive (Annex 1)

Although we are aware that it is difficult to define what is 'fair and reasonable', and that other parameters than the ones taken into account in this analysis could be of importance for such a definition, we have formulated the following hypothesis in order to aid the analysis:

Member States that today have higher CO_2-emissions per GWh generated heat and electricity will allocate fewer allowances per emitted ton of CO_2, than will Member States with lower CO_2 emissions per generated GWh.

If the hypothesis cannot be rejected, it would imply that the allocation plans have been 'fair'. It would also be a strong indication that for the energy sector, the National Allocation Plans meet criteria 3, 7 and 8 of the EU ETS Directive. Criterion 3 states that quantities of allowances shall be consistent with the potential of activities to reduce emissions; criterion 7 deals with how early action has been accommodated in the NAP

and criterion 8 is focused on in which manner are clean technology and energy efficient technologies taken into account (all criteria and their exact wordings can be found in annex I of this paper).

The argument that there is a link between CO_2 intensity, allocation/emitted ton of CO_2 and the Annex III criteria rests on three basic assumptions.

1. Low CO_2 emissions per generated GWh of energy gives less room for reductions in the energy sector than if the CO_2-emissions are higher per generated GWh of energy.

2. Low CO_2 emissions per generated GWh indicates that 'Early action' has been taken to a greater degree than if the CO_2-emissions are higher per generated GWh of energy.

3. The ratio between the current CO_2 emissions in the energy sector and the number of allocated allowances to the sector, gives an indication of the pressure put on the energy sector in order to achieve emission reductions in the sector.

Although each Member State should have published a NAP by May 2004 at the latest, there are still (July 2004) NAPs outstanding. These include Spain, France and Poland. This obviously makes it impossible to analyse the allocation plans of these Member States. Further, not all Member States provide data on how many CO_2 emissions allowances they will allocate to the energy sector, in the NAP. Thus it has not been possible to perform all comparisons for all Member States.

3 Methodology

The basic methodology of the study was to compare the allocation of CO_2 emission allowances to the energy sectors with the current emissions of CO_2 in the respective Member States. Further, the CO_2-intensity of the energy sector was calculated for each country. Finally, the ratio current emissions/allocated allowances, and the CO_2 intensities were normalised against the EU average and compared across the Member States.

3.1 System Boundaries

This study attempts to compare the CO_2 intensities of the same installations that will be included in the EU ETS. This means that it is not relevant to compare the CO_2 intensities of the entire energy sectors of the Member States, since significant parts of the sector are not included in the allocation plans. The EU ETS directive dictates that

only energy generation from combustion performed in installations with a capacity of 20MW or higher should be included in the emission trading scheme. Excluded fuels are municipal waste and hazardous waste.

Nuclear power, hydro power and wind power have been excluded when calculating the CO_2 intensities in order to achieve comparability with the NAPs. However, there are additional sources that should also be excluded in order to be in line with the EU directive but due to lack of specified data on generation from those sources they are included in the data presented here. These sources include geothermal energy, solar power, wave power and combustion of municipal and hazardous waste. Further, installations with a capacity below 20 MW should, according to the EU directive not be included either, but since there is no data available on the generation in installations smaller than 20 MW all installations are included in the data.

There were several Member States who had not submitted the NAPs as of June 01, among those large emitters like Spain, France and Poland. Further, note the review of the NAPs, currently carried out by the EU commission may result in changes in the NAPs. Thus the reader should be aware that the data presented here is not exhaustive, as well as subject to change.

3.2 Data Sources and Calculation Methodology

The main data source has been the International Energy Agency (IEA, 2004). The IEA data include CO_2-emissions from fuel combustion in the energy sector, specified for public energy plants, autoproducers and CHP. In order better align the study with the system defined in the EU ETS directive, data from Eurelectric on electricity production in nuclear power plants, wind power and hydro power was used. Fuel statistics from Euroheat was used in order to adjust the IEA data by excluding heat generation from non-combustion sources. Further, the data from Eurelectric and Euroheat was used to cross-check the data provided by the IEA. Some discrepancies are present, but the only Member State for which serious doubts on the data quality can be raised is Luxembourg. For Luxembourg, the generated electricity, according to IEA, is only half of the volumes according to Eurelectric.

IEA emission data is based on fuel input and the emission factors specified by the IPCC guidelines (Annex 2).

4 Results

4.1 CO_2 Intensities of the Energy Sectors of the EU Member States

In figure 1 CO_2 emissions per GWh generated heat and electricity are shown for the EU Member States in 2001.

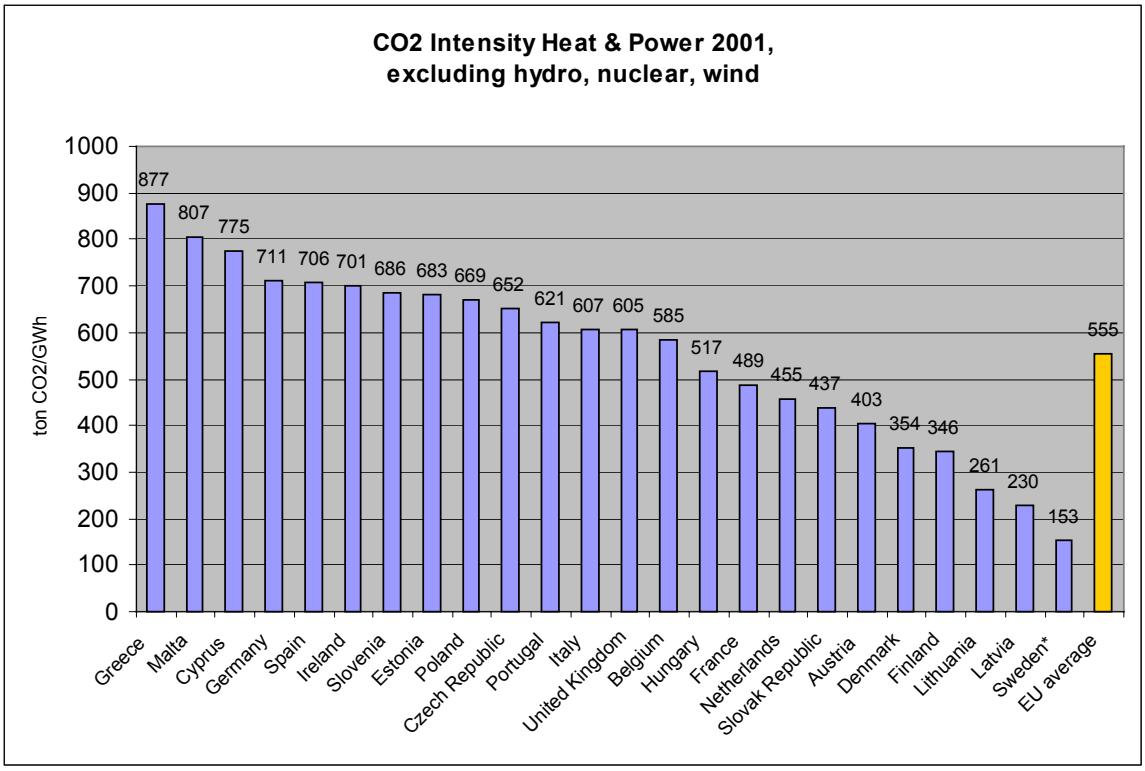

Figure 1. CO_2 intensities, energy generation, 2001. Nuclear power, hydropower and wind have been excluded. Numbers include combustion of biomass and waste (industrial-, municipal- and hazardous waste), as well as all other sources such as solar, geothermal and wave power. The EU average is not weighted, i e the different volumes of energy generated in each Member State have not been taken into account. *Heat generation from electric boilers, heat pumps and waste heat, which according to the EU ETS directive should be excluded, are included for all countries except Sweden. However, this should have little impact on the results since heat generation from those sources are less than 3 % for all Member States except Sweden. In Sweden however, 24 % of the heat is generated from either electric boilers, in heat pumps or waste heat (Euroheat, 2003), and this heat generation has been excluded in the CO_2 intensity in order to be in line with the definition of the EU ETS. Data from IEA (2004), Eurelectric (2003) and Euroheat (2003).

4.2 Allocation to the Energy Sectors of the Member States

In figure 2 the ratio allocated allowances/current emissions are shown for the Member States where such data was available as of June 01 2004. A value>1 indicates that the sectors will have a shortage of allowances in relation to current emissions, whereas a value <1 indicates that the sector will be allocated more allowances than they would need today.

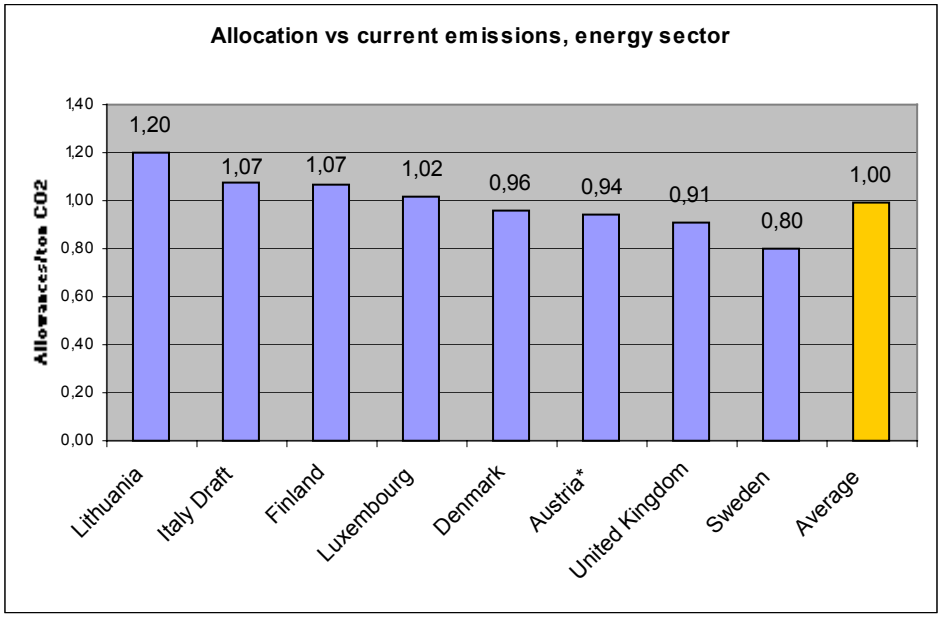

Figure 2. The ratio allocated allowances/current emissions. A value<1 means that current emissions are higher than the allocated amount of allowances. "Current" emissions imply either the latest year with available data, or the data used in the NAP. No earlier years than the average 98-01 has been used (Zetterberg et al, 2004). *Austria will use different allocation methodologies for heat and power, being slightly more generous to district heating than to power. For Sweden, the figure is not based on actual data, but it is the calculation rule that will be used in the allocation process.

4.3 Correlation between allocation and CO_2 intensity

Figure 3 shows the CO_2 intensities of the energy sectors and the ratio allocated allowances/current emissions for electricity and heat respectively. The values of each member state have been normalised against the EU average in order to achieve comparability (i e we have divided the value for the Member State with the EU average which is 1.00). If the hypothesis of this study should hold, a member State with a higher CO_2 index than average should allocate fewer allowances than the average and vice versa. Thus a Member State with a blue bar above 1 should, according to this argument, have a red bar below 1 and vice versa. The correlation coefficient of the normalised values of allocation/emissions and CO2 intensity is 0.11.

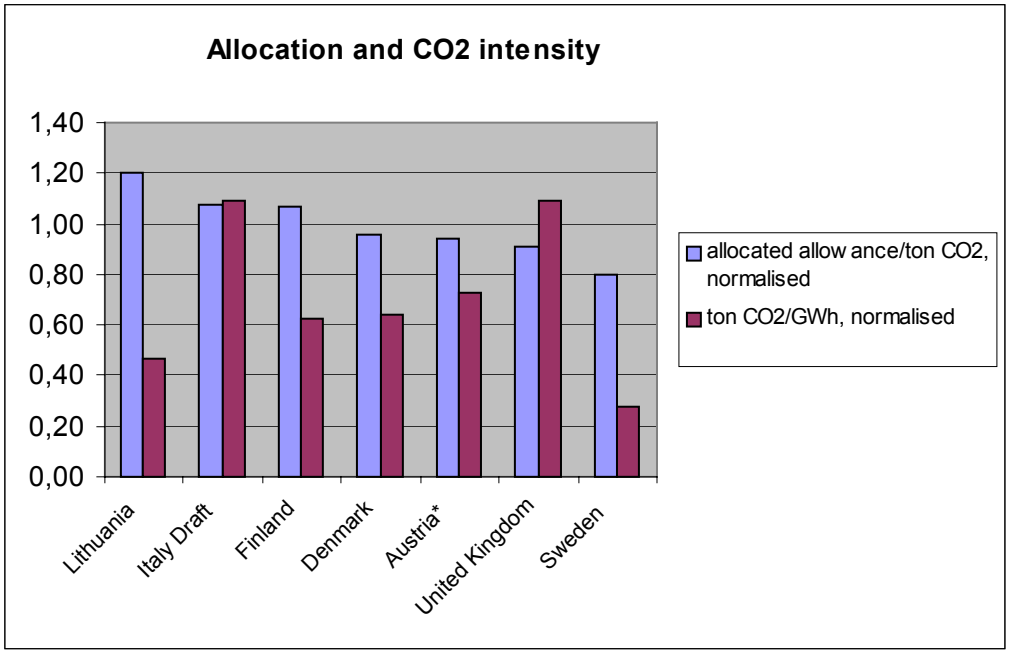

Figure 3. The light blue bars show the ratio between number of allocated allowances and emitted tons of CO_2, normalised against the average for all Member States where this data was available. A value >1 indicates an allocation that is more generous than in the average Member State. A value <1 indicates a stricter allocation than the average. The dark red bars show the CO_2 intensities, normalised against the EU average. Thus a number<1 indicate a more efficient energy production than the EU average, and a value>1 indicate higher emissions of CO_2/GWh produced energy than the EU average. *Austria will use different allocation methodologies for heat and power, being slightly more generous to district heating than to power. For Sweden, the figure is not based on actual data, but 0.8 is the factor that will be used to calculate the allocation to energy installations.

5 Uncertainties

5.1 System Boundaries

As far as possible, we have tried to use the same system boundaries in the study as those defined for the EU ETS. However, due to lack of data specification an exact match has not been possible to obtain. According to the EU ETS directive, emissions from combustion of municipal and hazardous waste should not be included in the ETS. It has not been possible to get reliable data on the use of those types of fuel in the Member States. Therefore, the emissions as well as the generated energy from the combustion of waste are included in the CO_2 indices shown in figure 1. However, data from Euroheat & Power (2003) on the share of municipal and hazardous waste of the total fuel input show that this is unlikely to have a significant effect on the CO_2 indices or alter the conclusions of this paper. The country with the highest percentage of waste in district heating and electricity generated in CHP (Sweden) has less than 10 % waste use, and that figure includes industrial waste, which is included in the EU ETS.

Likewise, the inclusion of installations below 20 MW capacity, and other sources of heat and electricity such as solar power, geothermal energy and wave energy is unlikely to have any impact on the conclusions of this paper. The reason is again that the volume of generated energy for those installations is very small relative the total generated energy, and that the CO_2 emissions from those sources are insignificant.

5.2 Data Quality

The quality of the data does also contain uncertainties. When data from the IEA, Eurelectric and Euroheat and Power, which form the base for this study, is compared to other data sources, e g individual power producers or national energy agencies, some minor discrepancies are discovered. Both IEA and Eurelectric state that the data reported to them sometimes lack in transparency and consistency, and that data in finer detail may be available at national or company level. However, in order to obtain the best comparability and keep the resources spent on data mining to a reasonable level, we have only used data from the three mentioned sources. Other data sources have been used for cross-reference, but no major discrepancies have been revealed.

The data on total energy generation and CO_2 emissions have an acceptable reliability, according to the IEA. However, it has not been possible to obtain reliable data specified for heat and power respectively. According to the IEA, the reason is that member states

report data for CHP in different ways. Consequently, we only present data aggregated to total energy generation.

5.3 Climate Variations

Climate variations can have an impact on the energy sectors, both in terms of the demand for energy in a Member State and on the CO_2 intensity in its energy sector. For instance, in countries where the dependency on hydropower is high, the amount of rainfall will affect the price of power, which in turn will affect the fuel mix in the energy market. If there is a lot of rain, the availability of water for power production will be good and the price on hydropower will be low. If it is a dry year, water for power production will be scarce, resulting in higher volumes of other energy sources. Naturally these effects can be particularly important when analysing a single year as in this study. Therefore it would be preferable to use average data for a number of years, but that has not been possible in this study. Instead, we used the latest year where data for all EU countries was available, namely 2001. 2001 was a wet year in the northern Europe. Thus the CO_2 intensity of Finland and Sweden may be slightly lower for the studied year than it is in an average year.

5.4 Sensitivity Analysis

What share of energy generation that is included in the EU ETS varies across Member States. Consequently, the basis for the indices presented in this study also represent different shares of the total energy production (figure 4). This means that the impact on the indices due to future changes in the energy system or variations in the generation of energy, for example due to climate variations, will vary between Member States. Several Member states have a significant share of electricity generation outside of the ETS. This is mainly due to nuclear and hydro being excluded. Sweden is the only Member State where a significant share of the total heat generation lies outside the EU ETS, approximately 25-30 %. Figure 4 shows the share of total energy generation included in the CO_2 indices.

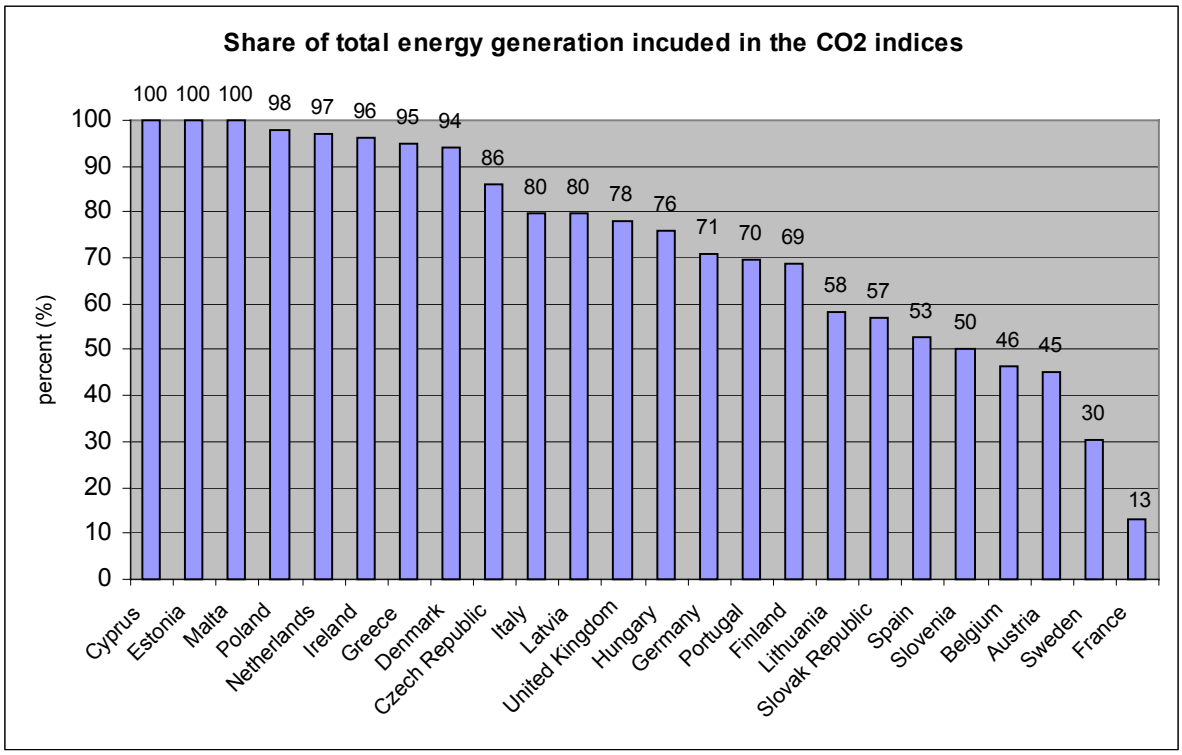

Figure 4. Share of total energy production that has formed the basis for the calculation of the CO_2-indicies, presented for each Member State. For example in Latvia 80 % of the total energy production has been included in the calculation. The rest of Latvia's energy generation, 20 %, will not be included in the EU ETS and has therefore been excluded in this study as well.

A conclusion from the numbers presented in figure 4 is that the CO_2-index for France is the most sensitive to changes in the energy system, and the indices for Cyprus, Estonia and Malta are the least sensitive to such changes.

6 Discussion

There are significant variations in CO_2 emissions per generated GWh energy between the Member states in the EU, as shown in figure 1. A full analysis of the differences lies beyond the scope of this study. However, it is clear that the proportion of biomass and CHP in the energy system is a dominating factor, probably explaining a majority of the differences in CO_2 intensity.

There is little correlation between allocated number of allowances and CO_2 emissions per GWh, as shown in figure 3. The correlation coefficient of normalised allocation/emissions and CO2 intensity is 0.11. Thus the hypothesis of the study, that Member States that today have higher CO_2-emissions per GWh generated heat and

electricity will allocate fewer allowances calculated per generated GWh to the energy sector, than will Member States with lower CO_2 emissions per generated GWh, must be rejected.

However, this must not necessarily mean that the NAPs are unreasonable and unfair. On top of the uncertainties discussed above, other factors can be of importance. Several Member States indicate that the have provided room for expected economic growth and increasing energy production. Some countries, e g Estonia and Lithuania, have indicated that large increases in energy generation will be needed in order to meet the demand from the rapidly growing economies of those Member States. Such a development could undermine our assumption that the ratio between the current CO_2 emissions to the energy sector and the number of allocated allowances to the sector gives an indication of the pressure put on the energy sector to achieve emission reductions.

There are also clear differences in the basic structures of the energy sectors between Member States, e g in terms of age and modernity of the infrastructure and what natural resources are readily available in each Member State. In Member States where coal is abundant, e g Poland and Germany, the energy sector has traditionally been relatively coal-intensive. By contrast, in Member States with large forestry sectors, e g Finland and Sweden, biomass has been used more widely for energy production for 10-20 years. On the other hand, it is possible to argue that this is the consequence of consistent energy policies possible to implement in other Member States as well. The barriers to trade fuel, be it coal, oil or biomass, have continuously been lowered over the last 30 years. Thus it should be possible to use a larger share of biomass also in countries that today have a large dependency on fossil fuels.

It is also important to note the differences in how large a proportion of the energy system that will be covered by the EU ETS (figure 4). The CO_2 intensity of Member States with only a fraction of their installations covered by the EU ETS, like France (13%) and Sweden (30%), will be more sensitive to future changes in the energy system than will the indices of Member States like Poland, where almost all (98 %) energy generation is included in the ETS.

To summarise, some Member States have accounted for significant growth in their NAP and some Member States have energy sectors that would have large stranded costs should they be forced to rapidly decrease their emissions. However, it seems unlikely that this would explain the large discrepancies between the generosity of the allocation and the efficiency of the energy sectors in some Member States. Rather, it seems that other political considerations have taken too much room in the design of the NAPs.

7 Conclusions

There are significant variations in the CO_2 intensities of the energy sectors in the EU Member States. The index varies from 877 ton CO_2/GWh (Greece), to 153 ton CO_2/GWh (Sweden). There are also significant variations in the ratio between allocated allowances and current emissions. This ratio varies from 1,2 ton allowances/ton CO_2 (Lithuania) to 0,8 allowances/ton CO_2 (Sweden). This analysis has only been possible to carry out for eight Member States.

There is very little correlation between CO_2 intensity in the energy sector and the generosity of the allocation to the sector in the respective Member States. Consequently we reject the hypothesis that Member States that today have higher CO_2-emissions per GWh generated heat and electricity will allocate fewer allowances calculated per generated GWh to the energy sector, than will Member States with lower CO_2 emissions per generated GWh.

This indicates that the National Allocation Plans are not fair and reasonable, and that they do not meet all of the Annex III criteria.

8 Further Research

It is clear that the data available for the type of analysis performed in this study needs to be improved.

It would be desirable to perform the analysis presented here for all NAPs once they are available. Since the analysis involves data on the current emissions form the energy sectors, such data also needs to be gathered, should it not be presented in the respective NAP.

Further, a specific analysis of heat and power generation respectively, once reliable data for this is available, would cast additional light of the situation in the EU energy sectors.

An analysis based on average data on emissions and generation, corrected for climate variations, would also provide higher certainty than the one presented here. Further efforts to secure data quality and comparability would also improve the certainty of the results and conclusions.

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Annex 1. Criteria for national allocation plans referred to in articles 9, 22 and 30 of Directive 2003/87/EC

1. The total quantity of allowances to be allocated for the relevant period shall be consistent with the Member State's obligation to limit its emissions pursuant to Decision 2002/358/EC and the Kyoto Protocol, taking into account, on the one hand, the proportion of overall emissions that these allowances represent in comparison with emissions from sources not covered by this Directive and, on the other hand, national energy policies, and should be consistent with the national climate change programme. The total quantity of allowances to be allocated shall not be more than is likely to be needed for the strict application of the criteria of this Annex. Prior to 2008, the quantity shall be consistent with a path towards achieving or over-achieving each Member State's target under Decision 2002/358/ EC and the Kyoto Protocol.

2. The total quantity of allowances to be allocated shall be consistent with assessments of actual and projected progress towards fulfilling the Member States' contributions to the Community's commitments made pursuant to Decision 93/389/EEC.

3. Quantities of allowances to be allocated shall be consistent with the potential, including the technological potential, of activities covered by this scheme to reduce emissions. Member States may base their distribution of allowances on average emissions of greenhouse gases by product in each activity and achievable progress in each activity.

4. The plan shall be consistent with other Community legislative and policy instruments. Account should be taken of unavoidable increases in emissions resulting from new legislative requirements.

5. The plan shall not discriminate between companies or sectors in such a way as to unduly favour certain undertakings or activities in accordance with the requirements of the Treaty, in particular Articles 87 and 88 thereof.

6. The plan shall contain information on the manner in which new entrants will be able to begin participating in the Community scheme in the Member State concerned.

7. The plan may accommodate early action and shall contain information on the manner in which early action is taken into account. Benchmarks derived from reference documents concerning the best available technologies may be employed by Member States in developing their National Allocation Plans, and these benchmarks can incorporate an element of accommodating early action.

8. The plan shall contain information on the manner in which 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 contain information on the arrangements by which due account will be taken of these comments before a decision on the allocation of allowances is taken.

10. The plan shall contain a list of the installations covered by this Directive with the quantities of allowances intended to be allocated to each.

11. The plan may contain information on the manner in which the existence of competition from countries or entities outside the Union will be taken into account.

Annex 2. IPCC Emission Factors

IPCC Emission factors	tC/TJ
Coking Coal	25,8
Other Bituminous Coal & Anthracite	25,8
Sub-Bituminous Coal	26,2
Lignite/Brown Coal	27,6
Oil Shale	29,1
Peat	28,9
Patent Fuel	25,8
Coke Oven Coke	29,5
Gas Coke	29,5
BKB/Peat Briquettes	25,8
Gas Works Gas	15,3
Coke Oven Gas	13
Blast Furnace Gas	66
Oxygen Steel Furnace Gas	66
Natural Gas	15,3
Crude Oil	20
Natural Gas Liquids	17,2
Refinery Feedstocks	20
Additives/Blending Components	20
Orimulsion	22
Input of origin not Crude or NGL	20
Refinery Gas	18,2
Ethane	16,8
Liquefied Petroleum Gases	17,2
Motor Gasoline	18,9
Aviation Gasoline	18,9
Gasoline type Jet Fuel	18,9
Kerosene type Jet Fuel	19,5
Kerosene	19,6
Gas/Diesel Oil	20,2
Residual Fuel Oil	21,1
Naphtha	20
White Spirit	20
Lubricants	20
Bitumen	22
Paraffin Waxes	20
Petroleum Coke	27,5
Non-specified Petroleum Products	20
Industrial Waste	29,9
Municipal Solid Waste (Non-Renewables)	29,9
Municipal Solid Waste (Renewables)	29,9
Primary Solid Biomass	29,9
Biogas	30,6
Liquid Biomass	20
Nonspec Prim Comb Renew & Waste	29,9
Charcoal	29,9

Note that although biomass has got an emission factor attached to them, emissions from the combustion of biomass are assumed to be zero.

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