

## **ECONOMIC EVALUATION OF SECTORAL EMISSION REDUCTION OBJECTIVES FOR CLIMATE CHANGE: TOP-DOWN ANALYSIS OF GREENHOUSE GAS EMISSION REDUCTION POSSIBILITIES IN THE EU**

### **EXECUTIVE SUMMARY**

As part of the “Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change” study, launched by the Environment DG, the PRIMES model has been used to provide insight on the contribution of energy producers and users to reduce CO<sub>2</sub> emissions in the EU. The results obtained from PRIMES model show the reduction potential of each sector under a system-wide analysis.

The PRIMES model includes all energy related CO<sub>2</sub> emissions and allocates them either to the energy production or consumption side. PRIMES model allocates emissions from electricity steam and district heat production to the supply side.<sup>1</sup> Thus, the emissions of the use of electricity, industrial heat or district heating are all allocated to the energy supply sector in the PRIMES model. Emissions in the energy user side include the combustion of fossil fuels. Thus, the use of natural gas to heat a home or gasoline to drive a car is allocated to households and transport sectors respectively.<sup>2</sup>

The PRIMES model baseline (i.e. “business-as-usual”) emission until 2010 were agreed upon in the “Shared Analysis” project, which was concluded under the auspices of the DG Transport and Energy in 1999. The Shared Analysis baseline included the policies and measures that were in place at the end of 1997. However, the effect of the environmental agreement with between European, Japanese and Korean car manufacturers (the “ACEA Agreement”) to reduce fuel consumption of cars to 140 grams CO<sub>2</sub> per km has been included in the baseline.

The results obtained from PRIMES model have been combined to the results obtained from the bottom up analysis performed by ECOFYS and AEA Technology<sup>3</sup>. The purpose was to define the least-cost optimum to reduce greenhouse gas emissions in each sector in the EU. Table A summarises these results assuming that the EU Member States achieve the –8% reduction target jointly.

The role of non-CO<sub>2</sub> greenhouse gases emissions in achieving the Kyoto target is significant. Under baseline conditions the emissions of non-CO<sub>2</sub> gases are projected to change by -6.8% from 1990 levels. CO<sub>2</sub> emissions, on the other hand increase at the same period by 4.1% (or 6.7% without the ACEA Agreement). The compliance to the Kyoto target in 2010 is achieved through a reduction of 271 Mt CO<sub>2</sub> for CO<sub>2</sub> emissions and 112 Mt CO<sub>2</sub> equivalent for non-CO<sub>2</sub> greenhouse gases.<sup>4</sup>

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<sup>1</sup> These include industrial boilers and industrial autoproducers of electricity and steam but the emissions from industrial boilers can be allocated to the industry where the activity takes place.

<sup>2</sup> The PRIMES model can analyse shifts due to changes in technology in energy demand side (e.g. if a diesel locomotive is replaced by electricity, the model allocates the emissions from transport to energy supply and the emissions from energy supply demand on the fuel mix that is used to generate electricity. In addition, the PRIMES model can show the emissions due to electricity and steam use in such a way that they are allocated to the energy demand sectors.

<sup>3</sup> C. Hendriks, D. de Jager, K. Blok et al. (2001): Bottom-up Analysis of Emission Reduction Potentials and Costs for Greenhouse Gases in the EU, Ecofys and AEA Technology, Utrecht, March 2001

<sup>4</sup> The “ACEA Agreement” is according to PRIMES projected to reduce CO<sub>2</sub> emissions by more than 80 Mt CO<sub>2</sub> in 2010. Consequently, the achievement of the Kyoto target for the EU becomes easier.

Table A: Allocation of effort by pollutant for achieving the Kyoto target under a regime with full flexibility (including the ACEA Agreement in the baseline)

	Baseline scenario			Emission reduction from 1990 levels		Compliance cost
	Mt CO2 eq.		% change	Mt CO2 eq.	% change from 1990	Euro99/tn of CO2 eq. Avoided
	1990	2010				
CO2 emissions	3068.1	3193.3	4.1	-146.0	-4.8	20.3
demand side	1936.6	2032.6	5.0	-25.5	-1.3	
industry <sup>1</sup>	561.4	449.5	-19.9	-145.9	-26.0	
transport <sup>2</sup>	734.8	919.0	25.1	152.0	20.7	
domestic	640.4	664.1	3.7	-31.6	-4.9	
supply side	1131.5	1160.7	2.6	-120.4	-10.6	
Non-CO2 GHGs emissions	1070.2	996.9	-6.8	-185.1	-17.3	20.3
<b>Total</b>	<b>4138.</b>	<b>4190.</b>	<b>1.3</b>	<b>-</b>	<b>-8.0</b>	<b>20.3</b>

Source: PRIMES, ECOFYS, AEA Technologies

<sup>1</sup> emissions from industrial boilers allocated in the demand side

<sup>2</sup> ACEA/JAMA/KAMA agreement is included

Concerning CO<sub>2</sub> emissions only, in the least-cost allocation of sectoral reduction objectives, the energy supply side is the key driver for emissions reduction (-150 Mt CO<sub>2</sub> from the baseline in 2010 or -120 Mt CO<sub>2</sub> from 1990 level) followed by the domestic (households and tertiary) sector (-55 Mt CO<sub>2</sub> from 2010 or -32 Mt from 1990). In the least-cost allocation, industrial sectors would reduce their emissions from 2010 by 34 Mt or by 146 Mt from 1990. It needs to be emphasised that between 1990 and 2010, the EU industry is projected to make significant energy efficiency improvements under baseline conditions, and that the industry will undergo significant structural changes. These lead to a reduction of CO<sub>2</sub> emissions by more than 110 Mt CO<sub>2</sub> in 2010.

In the EU energy system, the most important measures to achieve the Kyoto target are:

- Changes in the fuel mix in favour of less carbon intensive fuels, both in the energy supply and demand sides,
- Higher adoption of carbon free energy forms (e.g. wind energy, biomass/waste), especially in the energy supply side,
- Higher penetration of co-generation units for the production of electricity and steam to the detriment of industrial boilers,
- Structural changes in industry leading to less energy intensive processes,
- Continuation and reinforcement of energy conservation measures seeking better housekeeping in the energy demand side.

The power generation sector plays a crucial role because it has many low cost opportunities for emission reduction and because electrical technologies enable efficiency gains in the demand side. Transport remains a sector posing a particular policy challenge because of very high projected growth of CO<sub>2</sub> emissions and high adjustment costs. The implementation of the ACEA Agreement reduces the marginal abatement cost for the EU energy system €<sub>99</sub> 31.6/tCO<sub>2</sub> to €<sub>99</sub> 20.3/tCO<sub>2</sub> and the total compliance costs are reduced by €2.9 billion.

In order to achieve the reductions of CO<sub>2</sub> emissions in the EU energy system poses a major challenge. However, it should be clear that whatever policies or measures, including emission trading, are selected, the adjustment in the energy system needs to be based on the carbon content fuel used. Thus, whatever policies are chosen the end result will be that those fuels having higher carbon content will need to be less attractive than fuels with low or no carbon content. One EU wide policy to comply with the Kyoto target would be to charge the carbon content of fuels either directly or indirectly. According to the PRIMES calculations, with an increase of the price of the carbon content by €75 per tonne (which is about €20/tCO<sub>2</sub>) the EU would reach the Kyoto target, assuming that the emissions or non-CO<sub>2</sub> gases would be reduced by other policies and measures.

There are two drawbacks in a charge based on the carbon content of the fuel. One relates to the political difficulties in gaining EU-wide acceptance. The second is that there is no guarantee that the tax will lead to –8% reduction: if the tax is “too low”, the target will not be attained and if it is “too high”, there would be an overshoot of the target. Because of these inherent difficulties, it is recommended that other EU-wide policies and measures are considered to reach the Kyoto target.

Both national and EU-wide cap-and-trade of greenhouse gas emissions offers a new opportunity to reach the Kyoto target in such a manner that those wishing to over-comply would get compensated for their ambitions. Such dynamic incentives are one important reason why emission trading should be seriously considered. The least-cost allocation of objectives, as presented in this study, offers a starting point for allocating the emission reduction targets for participating sectors. Such targets should be seen as the best estimates, based on current knowledge.

In addition to emission trading, some other policies and measures could also assist in reducing energy related CO<sub>2</sub> emissions. Setting sector specific energy efficiency measures (in e.g. energy production or consumption) would reduce CO<sub>2</sub> emissions. This study shows the effects of reduction in energy consumption in terms of CO<sub>2</sub> emissions. Further, as de-carbonising of the energy system needs to occur in order to reduce CO<sub>2</sub> emissions, this could be targeted by specifically supporting low (e.g. natural gas as well as CHP) or no (renewables) carbon energy sources. This support could be direct (i.e. subsidies) or indirect (i.e. setting minimum shares of energy production from low or no-carbon sources e.g. through a Green Certificate scheme).

Based on the least-cost allocation of emission reduction objectives, the compliance costs of the EU would be €3.7 billion per annum during the first commitment period (2008-2012) of the Kyoto Protocol. This represents 0.06% of the projected GDP of the EU in 2010. It should be noted that due to the current EU energy market liberalisation, electricity prices for both industrial users and households have declined substantially over the last years. Thus, a least cost achievement of the Kyoto target would not place an unbearable burden on the European industry and citizens.

This study has not looked at the effect of the “flexibility mechanisms” of the Kyoto Protocol. Thus, the reduction target for all greenhouse gases for the EU as a whole has been chosen to be –8% throughout this study.

There are still a lot of uncertainties surrounding the developments in non-energy related CO<sub>2</sub> emissions as well as the non-CO<sub>2</sub> greenhouse gases (methane, nitrous oxides, HFCs, PFCs and SF<sub>6</sub>). The development of the non-energy related greenhouse gas emissions, which amounted to 1070 Mt CO<sub>2</sub> equivalent (or about 25% of all

emissions in the EU) in 1990, play a crucial role. As this study has used the results of the reduction potential of these non-energy related greenhouse gases, the uncertainties contained in the analysis of those gases, affect the results of this study as well.

During the validation of this study by industrial experts, a lot of comments were given to the forecasts of sectoral production. As these forecasts influence the projections of CO<sub>2</sub> emissions, it would be beneficial to undertake sensitivity analysis with the forecasts of how industrial sectors see their production develop up to 2010. Unfortunately, there was no time or resources to carry out such important, but time consuming, sensitivity analysis. Finally, it should be emphasised, that some policies and measures that have been approved after 1997 either in the EU (e.g. the Integrated Pollution Prevention and Control Directive) or the Member States (increased support to renewable energy) have not been included in this study. Thus, additional work is required to update the baseline. Such additional work could be complemented by the in-depth knowledge of industry specific sectoral forecasts of production.

### **Reference :**

P. Capros, N. Kouvaritakis and L. Mantzos. 2001. 'Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change. Top-down Analysis of Greenhouse Gas Emission Reduction Possibilities in the EU', National Technical University of Athens, Athens, March 2001.

[http://europa.eu.int/comm/environment/enveco/climate\\_change/sectoral\\_objectives.htm](http://europa.eu.int/comm/environment/enveco/climate_change/sectoral_objectives.htm)