# Impacts of energy taxation in the enlarged European Union, evaluation with GEM-E3 Europe

Nikos Kouvaritakis, Nikos Stroblos and Leonidas Paroussos, ICCS-NTUA

Tamas Revesz and Erno Zalai, CPAS-CUB University

Denise Van Regemorter, CES-KULeuven

Final Report
11.7.2005

Study for the European Commission DG TAXUD

Under the contract TAXUD/2003/DE/308

# 1. GENERAL OVERVIEW

The objective of this study is twofold: first analyze how the implementation of the EU minimum energy tax policy in the new Member States will affect the enlarged EU and secondly analyze how the energy taxation policy can contribute to the climate policy in the enlarged EU. The main elements of the new EU energy tax policy is an upward revision of the existing minimum tax rates on mineral oils and an inclusion of the energy products such as coal, natural gas and electricity in the tax base. Associated with assumptions regarding climate policy, different directions for the energy taxation policy are explored going from an increase of the minimum energy tax to the possibility of exempting the energy intensive sectors of the entire energy tax or of a CO2 component when a climate policy is implemented. The analysis in this study is done with the GEM-E3 general equilibrium model extended towards the new Member States.

The GEM-E3 model is an appropriate tool to evaluate such policies which have potentially an impact on the economy, the energy system and the environment of each member state and on the interactions between them. As GEM-E3 is a macro-sectoral general equilibrium model, it allows assessing the impact of an energy taxation reform in terms of economic indicators, such as GDP, employment and the balance of trade[1] and their sectoral implications, and in terms of environmental indicators, as CO2, SO2, NOx, VOC and PM emissions. Having a specific model for each of the EU countries (Luxembourg, Cyprus and Malta excluded) permits giving an indication on the distributive consequences between countries of energy taxation policy changes.

More precisely, the evaluated scenarios cover the following domain:

1) implementation of the EU energy tax directive (2003/96/EC) in the new Member States
2) implementation of more climate friendly energy tax rates by increasing the 'minimum' energy tax rates EU wide to the equivalent of 10Euro per ton CO2.
3) exemption from the energy taxation, either totally or partly, the sectors subject to other climate policy measures. The sectors considered for exemption are those participating in the allowance trading system[2] (electricity and heat generators and energy intensive sectors) as provided in the Directive ((2003)87/EC). The assumed climate policy combines for the first commitment period a domestic carbon tax with the allowance trading system such as to reach the Kyoto target for the EU, the trading system starting already in 2005. For the period beyond 2012 EU wide CO2 taxes of respectively 25€ and 45€ per ton of CO2 inducing a further reduction of the CO2 emission is assumed.

For the recycling of the tax revenues two assumptions are considered, either the tax income is used for reducing the public deficit or it is recycled through a reduction of the employer's social contribution.

The second section describes the existing tax structure as implemented in GEM-E3 based on the data received from DG TAXUD and IEA Energy Prices & Taxes Statistics, and the EU energy tax directive. In the third section the baseline scenario is briefly described and in the fourth section the policy scenarios are described more precisely and analysed. Finally section 5 concludes. The full detail of the results by country are given in an excel file in annex.

# 2. ENERGY TAX RATES TO BE IMPLEMENTED IN GEM-E3

## 2.1. The energy tax rates in 2003

Two sources are used for the computation of the tax rates to be implemented in GEM-E3, the nominal rates for the different fuels collected by TAXUD and the IEA Energy Prices & Taxes Statistics. The year 2003, the latest year for which all the necessary data are available, is the base year for the

[1] As a general equilibrium model, it can only give the impact on relative prices but not on the level of inflation.

[2] There is no clear definition of a criteria to define such sectors, however it is not within the scope of this proposal to arrive at such a definition, we will limit ourselves to a very general concept given the GEM-E3 sectoral classification.

implemented tax rates. Assumptions have been made by CUB-CES-NTUA to arrive at one rate per energy product and per sector as needed for GEM-E3.

The tax rates finally computed from these two sources are given in the two tables hereafter. For the implementation in GEM-E3, the price increase due to the tax was computed and then used as input for GEM-E3.

**Table 1: Energy tax rates in Agriculture and Industry in EURO/GJ in 2003**[3]

| | | AT | BE | DE | DK | FI | FR | EL | IE | IT | NL | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coal** | Electricity sector | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.00 | 0.00 | 0.00 | 0.32 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 |
| | Other | 0.00 | 0.00 | 0.00 | 1.16 | 1.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 |
| **Oil** | Electricity sector | 0.00 | 0.32 | 0.41 | 0.00 | 0.00 | 0.46 | 0.47 | 0.33 | 0.04 | 0.39 | 0.32 |
| | Energy Intensive sectors | 0.90 | 0.32 | 0.72 | 0.27 | 1.25 | 0.46 | 0.47 | 0.34 | 0.78 | 0.80 | 0.32 |
| | Other | 1.00 | 0.35 | 1.26 | 0.94 | 1.71 | 1.01 | 0.53 | 0.82 | 2.05 | 2.91 | 1.37 |
| **Gas** | Electricity sector | 0.00 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.00 | 0.30 | 0.69 | 0.19 | 0.44 | 0.33 | 0.00 | 0.00 | 0.46 | 0.06 | 0.00 |
| | Other | 1.02 | 0.30 | 0.69 | 0.67 | 0.52 | 0.33 | 0.00 | 0.00 | 0.49 | 0.70 | 0.00 |
| **Electricity** | Electricity sector | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.00 | 0.00 | 3.42 | 0.93 | 1.06 | 0.00 | 0.00 | 0.00 | 0.40 | 0.27 | 0.00 |
| | Other | 5.28 | 0.00 | 3.42 | 3.35 | 1.26 | 0.92 | 0.00 | 0.00 | 3.27 | 1.75 | 0.00 |
| **Oil for transport** | | 7.78 | 7.78 | 12.61 | 9.89 | 8.57 | 10.52 | 6.57 | 9.88 | 10.82 | 9.23 | 8.04 |

| | | SP | SE | UK | HU | PL | SI | CZ | SK | EE | LT | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coal** | Electricity sector | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.00 | 1.54 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Other | 0.00 | 1.82 | 0.68 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oil** | Electricity sector | 0.36 | 0.00 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.36 | 1.33 | 0.30 | 4.02 | 0.00 | 0.36 | 0.00 | 0.47 | 0.00 | 0.32 | 0.29 |
| | Other | 1.34 | 1.67 | 1.69 | 6.50 | 0.67 | 0.68 | 0.00 | 2.43 | 0.37 | 0.43 | 0.15 |
| **Gas** | Electricity sector | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.00 | 1.02 | 0.13 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Other | 0.00 | 1.20 | 0.66 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Electricity** | Electricity sector | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Energy Intensive sectors | 0.61 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Other | 0.61 | 0.00 | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oil for transport** | | 7.89 | 10.09 | 20.15 | 8.76 | 6.71 | 8.23 | 6.14 | 7.43 | 4.38 | 5.64 | 4.51 |

**Table 2: Energy tax rates for Households in EURO/GJ in 2003**

| **Household** | AT | BE | DE | DK | FI | FR | EL | IE | IT | NL | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coal** | 0.00 | 0.00 | 0.00 | 8.41 | 1.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 |
| **Oil** | 2.12 | 0.51 | 2.25 | 7.64 | 1.94 | 1.56 | 0.58 | 1.30 | 11.08 | 5.03 | 2.42 |
| **Gas** | 1.02 | 0.34 | 1.06 | 7.17 | 0.48 | 0.00 | 0.00 | 0.00 | 4.33 | 2.60 | 0.00 |
| **Electricity** | 5.56 | 0.38 | 5.69 | 24.79 | 2.06 | 2.89 | 0.00 | 0.00 | 11.11 | 13.50 | 0.00 |
| **Oil for transport** | 11.03 | 12.08 | 17.88 | 15.37 | 15.99 | 15.55 | 8.37 | 12.43 | 14.62 | 17.07 | 13.95 |

| **Household** | ES | SE | UK | HU | PL | SI | CZ | SK | EE | LT | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coal** | 0.00 | 8.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

[3] Energy intensive sectors: ferrous and non ferrous ore and metals (NACE-CLIO 13), non metallic mineral products (NACE-CLIO 15), metal products except machinery and transport equipment (NACE-CLIO 19) and paper and printing products (NACE-CLIO 47).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oil** | 2.33 | 9.59 | 1.90 | 8.98 | 1.34 | 1.00 | 0.00 | 0.47 | 0.74 | 0.54 | 0.60 |
| **Gas** | 0.00 | 5.90 | 0.00 | 0.00 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Electricity** | 1.42 | 6.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Oil for transport** | 10.59 | 15.73 | 21.96 | 11.02 | 10.14 | 11.99 | 8.35 | 8.20 | 6.12 | 7.50 | 7.26 |

## 2.2. The "minimum" energy tax rates

The "minimum rates" considered are those corresponding to the EU directive (2003/96/EC). These rates only apply on final energy demand exclusive of the non-energy use, and not on energy production or transformation. In the model implementation, the rates are adapted over time to the general relative price evolution in each country.

**Table 3: Minimum energy tax rates (EURO/GJ)**

| **Agriculture, industry and services** | 2004 | 2010 |
|---|---|---|
| Coal and coke | 0.15 | |
| Heavy fuel oil | 0.37 | |
| Light fuel oil | 0.58 | |
| Natural Gas | 0.15 | |
| Electricity | 0.14 | |
| Oil for transport purposes (diesel) | 8.10 | 8.86 |
| **Household** | | |
| Coal | 0.30 | |
| Oil | 0.58 | |
| Natural Gas | 0.30 | |
| Electricity | 0.28 | |
| Oil for transport purposes: petrol | 10.27 | 10.27 |
| diesel | 8.10 | 8.86 |

The following table shows the changes for the countries and sectors where the implementation of the minimum rates modifies the existing rates[4]. The minimum rates imply an increase of the energy tax in all new Member States, as in most of them only transport fuels were taxed and at a lower rate. For Hungary and Slovenia there is no increase in the tax on transport fuels, neither on light fuel for industry and household. For the other new Member States the increase in taxes are relatively comparable as to those implied for Greece, except for the Baltic countries where the increase in tax on transport fuels is higher. The increase is greater for the non oil products as they are mostly not taxed.

**Table 4: Tax increase (in %) from minimum tax implementation compared to the tax rates in 2003**

| | AT | BE | DE | DK | FI | FR | EL | IE | IT | NL | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry** | | | | | | | | | | | |
| Coal | Min | Min | Min | - | - | Min | Min | Min | Min | - | Min |
| reduced rate | Min | Min | Min | - | - | Min | Min | Min | Min | Min | Min |
| Heavy Fuel | - | 15% | - | - | - | - | - | 10% | - | - | 15% |
| reduced rate | Min | Min | Min | 36% | - | Min | Min | Min | Min | Min | Min |
| Light Fuel | - | 56% | - | - | - | - | - | - | - | - | - |
| Electricity | - | Min | - | - | - | - | Min | Min | - | - | Min |
| reduced rate | Min | Min | Min | - | - | Min | Min | Min | - | - | Min |
| Natural Gas | - | - | - | - | - | - | Min | Min | - | - | Min |
| reduced rate | Min | Min | Min | - | - | - | Min | Min | - | 131% | Min |
| **Transport** | | | | | | | | | | | |
| Diesel | 4% | 4% | - | - | - | - | 23% | - | - | - | 1% |
| Gasoline (95ron) | - | - | - | - | - | - | 21% | - | - | - | - |
| **Domestic/Household** | | | | | | | | | | | |

[4] MIN means that there were no tax and the minimum tax will be applied, % is the tax increase through the minimum tax, - the existing taxes are higher that the minimum tax.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | Min | Min | Min | - | - | Min | Min | Min | Min | - | Min |
| Light Fuel | - | 14% | - | - | - | - | - | - | - | - | - |
| Electricity | - | - | - | - | - | - | Min | Min | - | - | Min |
| Natural Gas | - | - | - | - | - | Min | Min | Min | - | - | Min |

| | ES | SE | UK | HU | PL | SI | CZ | SK | EE | LT | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry** | | | | | | | | | | | |
| Coal | Min | - | - | Min | Min | Min | Min | Min | Min | Min | Min |
| reduced rate | Min | - | 10% | Min | Min | Min | Min | Min | Min | Min | Min |
| Heavy Fuel | 4% | - | - | - | Min | 3% | Min | - | Min | 15% | 28% |
| reduced rate | Min | - | 26% | Min | Min | Min | Min | Min | Min | Min | Min |
| Light Fuel | - | - | - | - | - | - | Min | - | - | 7% | Min |
| Electricity | - | Min | - | Min | Min | Min | Min | Min | Min | Min | Min |
| reduced rate | Min | Min | - | Min | Min | Min | Min | Min | Min | Min | Min |
| Natural Gas | Min | - | - | Min | Min | - | Min | Min | Min | Min | Min |
| reduced rate | Min | - | 14% | Min | Min | Min | Min | Min | Min | Min | Min |
| **Transport** | | | | | | | | | | | |
| Diesel | 3% | - | - | - | 21% | - | 32% | 9% | 85% | 44% | 80% |
| Gasoline (95ron) | - | - | - | - | - | - | 18% | 23% | 60% | 32% | 34% |
| **Domestic/Household** | | | | | | | | | | | |
| Coal | Min | - | Min | Min | Min | Min | Min | Min | Min | Min | Min |
| Light Fuel | - | - | - | - | - | - | Min | 23% | - | 7% | - |
| Electricity | - | - | Min | Min | Min | Min | Min | Min | Min | Min | Min |
| Natural Gas | Min | - | Min | Min | Min | 14% | Min | Min | Min | Min | Min |

The impact might be somewhat less important than what is suggested in the table when linking it with the shares of the energy products in the total final energy consumption. Table 5 gives, by country, the share of the energy products in the total final energy consumption in each broad sectoral category. The use of coal by household is only significant in Ireland and Poland, practically no gas is used in Greece, Portugal and Sweden; in the industry coal is mainly used for electricity production (not taxed) and in the non-chemical energy intensive industries, where moreover only the energy use is taxed.

**Table 5: Share of energy products in total final energy consumption, excluding consumption for transport purposes, in 2000**

| | | AT | BE | DE | DK | FI | FR | EL | IE | IT | NL | PT | ES | SE | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | Energy Intensive | 8.9% | 31.2% | 22.8% | 17.8% | 10.4% | 19.9% | 31.3% | 2.9% | 12.3% | 14.1% | 12.8% | 8.3% | 11.1% | 18.6% |
| Oil | Energy Intensive | 9.7% | 7.3% | 5.7% | 24.9% | 8.2% | 11.5% | 35.8% | 53.8% | 17.5% | 15.9% | 39.7% | 22.7% | 11.9% | 5.5% |
| Gas | Energy Intensive | 41.7% | 37.8% | 44.7% | 28.9% | 11.8% | 37.9% | 5.6% | 21.8% | 44.7% | 44.7% | 16.1% | 40.4% | 3.7% | 48.5% |
| Electricity | Energy Intensive | 27.3% | 23.7% | 26.7% | 28.3% | 32.2% | 30.6% | 27.3% | 21.5% | 25.5% | 25.3% | 19.5% | 25.2% | 34.7% | 27.5% |
| Renewable | Energy Intensive | 12.4% | 0.0% | 0.0% | 0.1% | 37.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 11.8% | 3.4% | 38.7% | 0.0% |
| Coal | Other | 1.4% | 0.9% | 1.7% | 2.8% | 1.7% | 2.3% | 0.3% | 0.8% | 2.0% | 0.3% | 0.9% | 1.1% | 1.3% | 1.7% |
| Oil | Other | 20.6% | 29.5% | 24.4% | 32.0% | 37.7% | 22.7% | 49.6% | 46.9% | 21.3% | 9.0% | 47.8% | 31.3% | 28.7% | 22.4% |
| Gas | Other | 27.0% | 40.0% | 34.5% | 18.3% | 5.4% | 33.5% | 2.1% | 18.2% | 25.8% | 61.7% | 5.2% | 18.3% | 2.9% | 39.6% |
| Electricity | Other | 41.5% | 29.0% | 37.4% | 41.3% | 43.1% | 37.1% | 42.0% | 30.6% | 46.4% | 28.3% | 42.2% | 44.6% | 54.9% | 35.2% |
| Renewable | Other | 9.4% | 0.7% | 2.0% | 5.6% | 12.1% | 4.4% | 5.9% | 3.3% | 4.6% | 0.8% | 3.9% | 4.6% | 12.3% | 1.1% |
| Coal | Household | 3.8% | 2.3% | 1.5% | 0.0% | 0.4% | 1.5% | 0.5% | 20.6% | 0.2% | 0.0% | 0.0% | 0.4% | 0.0% | 3.7% |
| Oil | Household | 29.1% | 39.6% | 33.0% | 28.5% | 30.6% | 25.5% | 53.8% | 36.2% | 18.4% | 0.9% | 24.1% | 34.0% | 16.7% | 7.0% |
| Gas | Household | 23.1% | 34.8% | 40.3% | 24.5% | 0.6% | 24.4% | 0.3% | 17.6% | 56.8% | 78.6% | 3.5% | 17.0% | 1.9% | 66.5% |
| Electricity | Household | 20.0% | 21.6% | 18.9% | 32.8% | 42.8% | 28.8% | 27.4% | 24.0% | 14.5% | 18.5% | 30.9% | 31.6% | 69.5% | 22.3% |
| Renewable | Household | 24.0% | 1.7% | 6.4% | 14.1% | 25.7% | 19.7% | 18.0% | 1.6% | 10.1% | 2.0% | 41.5% | 17.0% | 11.9% | 0.5% |

| | | HU | PL | SI | CZ | SK | EE | LT | LV |
|---|---|---|---|---|---|---|---|---|---|
| Coal | Energy Intensive | 15.1% | 39.8% | 6.4% | 47.3% | 45.2% | 9.3% | 0.8% | 1.4% |
| Oil | Energy Intensive | 31.5% | 15.8% | 9.9% | 21.5% | 34.1% | 11.9% | 11.5% | 30.3% |
| Gas | Energy Intensive | 38.3% | 26.6% | 50.2% | 18.4% | 0.0% | 47.7% | 79.4% | 56.1% |
| Electricity | Energy Intensive | 15.0% | 15.3% | 33.5% | 12.6% | 20.7% | 20.8% | 7.9% | 11.1% |
| Renewable | Energy Intensive | 0.0% | 2.5% | 0.0% | 0.2% | 0.0% | 10.4% | 0.4% | 1.1% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coal | Other | 1.3% | 25.1% | 3.2% | 19.9% | 5.7% | 4.7% | 7.6% | 4.2% |
| Oil | Other | 11.7% | 29.9% | 38.0% | 6.9% | 9.8% | 38.6% | 18.9% | 19.5% |
| Gas | Other | 60.1% | 9.8% | 22.8% | 40.2% | 61.5% | -1.5% | 25.9% | 15.9% |
| Electricity | Other | 25.1% | 26.9% | 27.1% | 30.6% | 22.8% | 25.3% | 38.4% | 27.5% |
| Renewable | Other | 1.8% | 8.4% | 8.8% | 2.5% | 0.2% | 32.9% | 9.2% | 33.0% |
| Coal | Household | 4.0% | 34.7% | 0.8% | 15.3% | 2.6% | 4.4% | 2.3% | 2.4% |
| Oil | Household | 7.0% | 7.4% | 38.7% | 2.0% | 0.7% | 11.5% | 9.2% | 5.6% |
| Gas | Household | 64.3% | 24.8% | 6.1% | 52.4% | 72.9% | 7.0% | 12.0% | 12.1% |
| Electricity | Household | 18.6% | 14.7% | 22.2% | 30.4% | 23.8% | 33.3% | 17.5% | 19.4% |
| Renewable | Household | 6.0% | 18.4% | 32.2% | 0.0% | 0.0% | 43.8% | 58.9% | 60.5% |

The ex-ante price increase, implied by the minimum tax and implemented in the model, is given in the next table. It is the price increase through the minimum tax of the average energy product price inclusive existing energy taxes in 2000 (but excluding VAT).

**Table 6: Ex-ante Price Increase through Minimum Tax**
(for average energy prices of 2000, incl. existing taxes)

| | | AT | BE | DE | DK | FI | FR | EL | IE | IT | NL | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal | Energy Intensive | 8.0% | 8.2% | 6.5% | 0.0% | 0.0% | 4.2% | 6.2% | 11.7% | 10.3% | 0.0% | 11.7% |
| | Other | 8.0% | 8.2% | 6.5% | 0.0% | 0.0% | 4.2% | 6.2% | 11.7% | 10.3% | 0.0% | 11.7% |
| Oil | Energy Intensive | 0.0% | 1.0% | 0.0% | 1.9% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.8% |
| | Other | 0.0% | 2.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Gas | Energy Intensive | 4.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 2.7% | 5.1% | 0.0% | 2.1% | 2.4% |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 2.7% | 5.1% | 0.0% | 0.0% | 2.4% |
| Electricity | Energy Intensive | 1.2% | 1.0% | 0.0% | 0.0% | 0.0% | 1.3% | 1.1% | 0.9% | 0.0% | 0.0% | 0.7% |
| | Other | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.1% | 0.9% | 0.0% | 0.0% | 0.7% |
| Oil for transport | Industry | 6.2% | 6.2% | 0.0% | 0.0% | 1.5% | 0.0% | 15.1% | 0.0% | 0.0% | 0.0% | 5.0% |
| Coal | Household | 3.3% | 3.2% | 2.7% | 0.0% | 0.0% | 3.7% | 4.1% | 4.4% | 8.5% | 0.0% | 9.2% |
| Oil | Household | 0.0% | 0.9% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Gas | Household | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 3.9% | 4.4% | 3.8% | 0.0% | 0.0% | 1.9% |
| Electricity | Household | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.4% | 1.0% | 0.0% | 0.0% | 0.8% |
| Oil for transport | Household | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 9.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| | | | | | | | | | | | | |
| | | ES | SV | UK | HU | PL | SL | CZ | LV | LT | EE | SK |
| Coal | Energy Intensive | 7.1% | 0.0% | 0.6% | 11.5% | 10.1% | 16.0% | 16.0% | 16.0% | 16.0% | 16.0% | 15.6% |
| | Other | 7.1% | 0.0% | 0.0% | 11.5% | 10.1% | 13.9% | 26.9% | 13.9% | 13.9% | 13.9% | 15.6% |
| Oil | Energy Intensive | 0.2% | 0.0% | 1.7% | 0.0% | 12.2% | 0.3% | 12.3% | 2.4% | 1.4% | 12.4% | 0.0% |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 8.0% | 6.0% | 0.8% | 1.9% | 0.0% |
| Gas | Energy Intensive | 3.3% | 0.0% | 0.7% | 4.6% | 4.4% | 0.0% | 3.9% | 4.6% | 4.6% | 4.6% | 5.7% |
| | Other | 3.3% | 0.0% | 0.0% | 4.6% | 4.4% | 0.0% | 3.9% | 4.6% | 4.6% | 4.6% | 5.7% |
| Electricity | Energy Intensive | 0.0% | 1.6% | 0.0% | 1.0% | 1.3% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% |
| | Other | 0.0% | 1.6% | 0.0% | 1.0% | 1.3% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% |
| Oil for transport | Industry | 5.8% | 0.0% | 0.0% | 0.5% | 14.6% | 3.7% | 17.9% | 32.6% | 22.3% | 33.9% | 8.9% |
| Coal | Household | 11.9% | 0.0% | 3.9% | 14.5% | 10.2% | 17.7% | 36.8% | 17.7% | 17.7% | 17.7% | 30.7% |
| Oil | Household | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 6.5% | 0.0% | 0.5% | 0.0% | 2.2% |
| Gas | Household | 2.7% | 0.0% | 4.2% | 7.8% | 5.7% | 0.9% | 6.6% | 7.4% | 7.4% | 7.4% | 11.8% |
| Electricity | Household | 0.0% | 0.0% | 0.9% | 1.6% | 1.7% | 1.8% | 2.1% | 1.8% | 1.8% | 1.8% | 2.1% |
| Oil for transport | Household | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 9.1% | 15.9% | 14.6% | 24.3% | 10.3% |

# 3. THE BASELINE SCENARIO

## 3.1. Exogenous assumptions

A baseline scenario elaborated with a CGE model such as GEM-E3, cannot be considered as a forecast. It gives however a consistent general evolution of the economic activity given exogenous assumptions on the main driving forces and represents the benchmark to which to compare the different policy scenarios. One should however have in mind that, in case of scenarios related to the Kyoto target, the evolution of GHG emissions in the baseline scenario conditions the EU global reduction effort, as the target is defined in terms of the 1990 emissions. It is therefore an important parameter in the evaluation of a climate change policy.

It is based on the existing baseline of GEM-E3, constructed within the 5th Framework Research Program project DAT-GEM-E3 in which CES-KULeuven (coordinator), ICCS-NTUA and CPAS-BUES participate. For the period until 2005 it is in line with the Spring EU Commission forecast and for 2005-2030 with the study "European Energy and Transport – Trends to 2030" published by the European Commission Directorate-General for Energy and Transport (January 2003) which assumed an average growth rate around 2%. The assumed oil and gas price evolution is given in the table hereafter[5].

**Table 7: World energy prices assumptions**

| International Fuel Price (Euro'00 per toe) | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Crude oil | 150.4 | 158.4 | 174.2 | 190.0 | 205.9 | 221.7 |
| Natural gas | 118.8 | 134.6 | 150.4 | 162.3 | 174.2 | 182.1 |

For technical progress general assumptions have been made in line with past observations for energy efficiency and labour productivity and without sectoral or country differentiation. Regarding public policy no specific assumptions regarding climate change are assumed with the exception of the ACEA agreement for car fuel efficiencies and the energy taxes in the EU countries.

The EU minimum tax directive is implemented in the EU15 countries in the baseline, whereas for the new Member States the current rates are considered. The existing rates were translated into an average tax per sector and per energy category (coal, oil, natural gas and electricity) and implemented in GEM-E3.

## 3.2. The projections for 2000-2030

The endogenous variables of the GEM-E3 model include (in volume for each sector and each country) the supply (production and imports) and demand (use in production, private and public consumption, investments and exports) of goods and services, the sources and uses of material, energy, labour and capital inputs. The model also computes, for each sector and each country, the changes in relative prices of domestic production, exports, imports and changes in primary factor incomes (average wage rate and return on capital). In the following table the macroeconomic growth for the EU, inclusive the New Member States, as a whole is given. The projected average growth rate is around 2.5% with a decoupling of the GDP growth and the energy demand over the entire projection horizon and thus a moderate growth in CO2 emissions. The evolution of the CO2 emissions implies still in 2010 a reduction of approx. 14% of the baseline CO2 emissions for the EU15 in order to reach the Kyoto target translated in terms of CO2 emissions.

[5] It does not take into account the recent increase in oil prices

**Table 8: EU Macroeconomic growth (22 countries)**
**(annual growth rate except for * where difference)**

| | 2005/2010 | 2010/2015 | 2015/2020 | 2020/2025 | 2025/2030 |
|---|---|---|---|---|---|
| **Macroeconomic Aggregates** | | | | | |
| *Gross Domestic Product* | 2.5% | 2.6% | 2.5% | 2.4% | 2.3% |
| *Employment* | 0.8% | 0.2% | 0.0% | 0.0% | -0.2% |
| *Private Consumption* | 2.0% | 2.2% | 2.2% | 2.2% | 2.1% |
| *Investment* | 3.9% | 2.4% | 2.4% | 2.3% | 2.3% |
| *Final Energy Consumption* | 1.6% | 1.9% | 1.8% | 1.8% | 1.8% |
| *Share Coal** | -0.1% | -0.1% | -0.1% | -0.1% | -0.2% |
| *Share Oil** | -0.3% | -0.9% | -1.2% | -1.2% | -1.0% |
| *Share Gas** | -0.5% | -0.4% | -0.3% | -0.3% | -0.3% |
| *Share Electricity** | 0.9% | 1.4% | 1.6% | 1.6% | 1.4% |
| *Exports to RW* | 3.8% | 5.0% | 4.4% | 4.0% | 3.4% |
| *Imports from RW* | 3.1% | 1.5% | 1.9% | 2.2% | 2.5% |
| *Real Wage Rate* | 0.7% | 2.8% | 3.1% | 3.1% | 3.3% |
| *Relative Consumer Price* | 0.9% | -0.3% | 0.0% | 0.2% | 0.5% |
| *Terms of Trade* | -0.5% | -1.6% | -1.1% | -0.7% | -0.3% |
| *Current Account (% of GDP)** | 0.9% | 2.1% | 1.7% | 1.5% | 1.1% |
| | | | | | |
| **Total Atmospheric Emissions** | | | | | |
| *CO2 Emissions* | 1.2% | 1.3% | 1.1% | 1.1% | 1.0% |
| *NOX Emissions* | -3.5% | 1.4% | 1.2% | 1.2% | 1.1% |
| *SO2 Emissions* | 0.9% | 1.2% | 1.1% | 1.1% | 1.0% |
| *VOC Emissions* | -0.8% | 1.7% | 1.5% | 1.5% | 1.4% |
| *PM Emissions* | 1.1% | 1.3% | 1.2% | 1.2% | 1.1% |

The sectoral evolution for the domestic production and the EU exports are given in the next table. They imply a slow shift towards a more service oriented economy though still limited. It is rather more pronounced in the exports in the period 2005/2010. This shift towards less energy intensive sectors contributes to the slower growth of CO2 emissions.

**Table 9: EU sectoral evolution (22 countries)**
**(annual growth rate)**

| **Sectoral Aggregates** | 2005/2010 | 2010/2015 | 2015/2020 | 2020/2025 | 2025/2030 |
|---|---|---|---|---|---|
| **Domestic Production in Volume** | | | | | |
| *Agriculture* | 1.5% | 1.9% | 1.9% | 1.8% | 1.8% |
| *Energy Production* | 0.4% | 0.9% | 0.7% | 0.7% | 0.7% |
| *Ferrous and non ferrous metals* | 2.5% | 2.2% | 1.9% | 1.8% | 1.5% |
| *Chemical Products* | 2.0% | 2.5% | 2.3% | 2.1% | 1.8% |
| *Other energy intensive* | 2.1% | 2.0% | 1.8% | 1.8% | 1.6% |
| *Electric Goods* | 2.4% | 2.6% | 2.3% | 2.1% | 1.8% |
| *Transport equipment* | 3.4% | 2.8% | 2.5% | 2.4% | 2.1% |
| *Other Equipment Goods* | 3.3% | 2.7% | 2.4% | 2.2% | 1.9% |

| | | | | | |
|---|---|---|---|---|---|
| *Consumer Goods Industries* | 1.8% | 2.3% | 2.2% | 2.1% | 2.0% |
| *Construction* | 3.0% | 2.2% | 2.2% | 2.2% | 2.1% |
| *Telecommunication Services* | 2.1% | 2.5% | 2.4% | 2.4% | 2.3% |
| *Transport* | 2.3% | 3.0% | 2.8% | 2.8% | 2.5% |
| *Services of credit and insurances* | 1.9% | 2.5% | 2.4% | 2.4% | 2.3% |
| *Other Market Services* | 2.2% | 2.5% | 2.4% | 2.4% | 2.3% |
| *Non Market Services* | 1.7% | 1.7% | 1.7% | 1.7% | 1.7% |
| | | | | | |
| **Exports in Volume** | | | | | |
| *Agriculture* | 8.0% | 1.9% | 1.9% | 1.8% | 1.7% |
| *Energy Exports* | 0.2% | 0.8% | 0.7% | 0.7% | 0.6% |
| *Ferrous and non ferrous metals* | 4.3% | 2.2% | 2.0% | 1.9% | 1.6% |
| *Chemical Products* | 1.4% | 2.5% | 2.3% | 2.2% | 2.0% |
| *Other energy intensive* | -4.1% | 2.0% | 1.9% | 1.8% | 1.7% |
| *Electric Goods* | -3.5% | 2.7% | 2.5% | 2.3% | 2.0% |
| *Transport equipment* | -3.3% | 2.7% | 2.5% | 2.4% | 2.1% |
| *Other Equipment Goods* | 1.9% | 2.8% | 2.5% | 2.3% | 2.0% |
| *Consumer Goods Industries* | 8.0% | 2.3% | 2.2% | 2.1% | 2.0% |
| *Construction* | 6.0% | 2.2% | 2.3% | 2.3% | 2.3% |
| *Telecommunication Services* | -5.5% | 2.6% | 2.6% | 2.6% | 2.5% |
| *Transport* | 4.1% | 3.2% | 3.1% | 3.0% | 2.9% |
| *Services of credit and insurances* | 4.7% | 2.6% | 2.6% | 2.6% | 2.5% |
| *Other Market Services* | 5.3% | 2.5% | 2.5% | 2.5% | 2.4% |
| *Non Market Services* | 1.7% | 2.0% | 2.0% | 2.0% | 2.0% |

# 4. THE POLICY SCENARIOS

## 4.1. The EU enlargement and the minimum energy tax directive (scenario 1)

### *4.1.1. Assumptions*

The energy tax directive in its agreed form is implemented in the new Member States. The tax rates implemented in this scenario were computed following the same procedure as the one used for the computation of average tax rates for the EU15 in the baseline. As the GEM-E3 model runs in 5 year period, the transitional regulation as foreseen in the EU directive are not relevant for this exercise as most are allowed till January 2008.

Two possibilities for the revenue recycling are considered:

1. the revenues are used to decrease the public deficit which alleviates the financial constraint of private economic agents and reduces the interest rate. This is modelled by imposing that the EU current account remains constant relative to GDP compared to the reference case, limiting the resource allocation induced by the policy to the EU.

2. the revenues are recycled through a decrease of the social security contributions such as to ensure budget neutrality compared to the reference scenario; the reduction is uniform across all sectors. In this scenario the current account can freely adjust.

### *4.1.2. Results for the EU*

The macroeconomic results for the EU as a whole are reproduced in Table 10. The impact of the policy is limited to the new Member States where the minimum taxes are implemented and induces hardly any change at EU level.

**Table 10: Macroeconomic impact at EU level (22 countries) of the implementation of the minimum energy tax in the new Member States**
**(% difference compared to reference, except for * where difference)**

| Minimum Energy tax in new Member States from 2010 onwards | | |
|---|---|---|
| | without direct recycling of tax revenue | with SS recycling of tax revenue |
| | 2010 | 2010 |
| **Macroeconomic Aggregates** | | |
| *Gross Domestic Product* | 0.00% | 0.00% |
| *Employment* | 0.00% | 0.06% |
| *Private Consumption* | 0.00% | 0.00% |
| *Investment* | 0.00% | 0.00% |
| *Final Energy Consumption* | -0.12% | -0.11% |
| *Share Coal** | -0.17% | -0.17% |
| *Share Oil** | 0.08% | 0.08% |
| *Share Gas** | 0.02% | 0.02% |
| *Share Electricity** | 0.07% | 0.07% |
| *Exports to RW* | -0.01% | 0.00% |
| *Imports from RW* | -0.01% | -0.01% |
| *Real Wage Rate* | 0.02% | -0.01% |
| *Relative Consumer Price* | 0.01% | 0.01% |
| *Real Interest Rate* | -0.01% | 0.00% |
| *Terms of Trade* | 0.01% | 0.00% |
| *Current Account (% of GDP)** | 0.00% | 0.00% |
| | | |
| **Total Atmospheric Emissions** | | |
| *CO2 Emissions* | -0.52% | -0.50% |
| *NOX Emissions* | -0.27% | -0.26% |
| *SO2 Emissions* | -1.00% | -0.98% |
| *VOC Emissions* | -1.00% | -0.98% |
| *PM Emissions* | -1.07% | -1.05% |
| **Environmental Policy** | | |
| *Energy Tax (% of GDP)** | 0.01% | 0.01% |
| *Reduction of Social Security Rate** | 0.00% | 0.21% |
| | | |
| **Welfare**[6] | | |
| *Economic Welfare* | -0.01% | 0.00% |

[6] Economic welfare corresponds to the change of the utility function derived from the change in consumption and leisure, total welfare includes the environmental benefits/damages expressed in utility equivalent derived from the change in emissions (cf. annex with short description of GEM-E3). Local benefits are the benefits from the reduction of local pollutant such as NOx, SO2, PM and VOC expressed in monetary terms.

| | | |
|---|---|---|
| *Total Welfare* | 0.00% | 0.01% |
| *Local Benefits (% of GDP)** | 0.01% | 0.01% |

In the New Member States the impact is larger, as can be seen in Table 11. Final energy consumption decreases from 1 to 4% with only a very small impact on economic growth and welfare. The CO2 emissions are more reduced than the energy consumption because of the decreasing share of coal. The share of coal and gas are decreasing because oil is already partly taxed in most countries. Also electricity increases its share because the price of electricity increases relatively less as the minimum tax per GJ is the same for coal, gas and electricity. As expected, a recycling of the tax income through a reduction of the employers' social security contribution allows limiting more the negative impact of the policy measure than a recycling within the public budget, as it reduces the distortion in the labour market. This is observed both in terms of welfare and of employment in all new Member States. The impact on employment is the greatest in those countries where the reduction in the social security rate is the highest.

**Table 11: Macroeconomic impact for the new Member States in 2010**
**(% difference compared to reference, except for * where difference)**

| **Without direct recycling of the tax revenue** | | | | 2010 | | | | |
|---|---|---|---|---|---|---|---|---|
| **Macroeconomic Aggregates** | Hungary | Poland | Slovenia | Czech Republic | Slovakia | Estonia | Lithuania | Latvia |
| *Gross Domestic Product* | -0.01% | -0.04% | -0.02% | 0.02% | 0.00% | 0.04% | 0.06% | -0.01% |
| *Employment* | 0.00% | 0.04% | 0.00% | 0.06% | 0.05% | 0.03% | 0.02% | -0.02% |
| *Private Consumption* | -0.06% | -0.35% | 0.82% | -1.23% | -1.09% | -1.01% | -0.67% | -0.88% |
| *Investment* | -0.02% | -0.06% | 0.04% | -0.10% | -0.09% | -0.11% | -0.05% | -0.05% |
| *Final Energy Consumption* | -1.24% | -2.82% | -0.81% | -4.29% | -2.58% | -1.42% | -0.97% | -1.19% |
| *Share Coal** | -0.49% | -1.31% | -0.47% | -2.16% | -1.18% | -0.57% | -0.17% | -0.33% |
| *Share Oil** | 0.50% | 0.34% | 0.21% | 0.46% | 0.46% | 0.28% | -0.17% | 0.08% |
| *Share Gas** | -0.20% | 0.02% | 0.07% | 0.02% | -0.06% | 0.09% | 0.05% | -0.07% |
| *Share Electricity** | 0.19% | 0.96% | 0.18% | 1.68% | 0.79% | 0.20% | 0.29% | 0.32% |
| *Exports to RW (total for NMS)* | -0.05% | 0.32% | -0.56% | 0.66% | 0.58% | 0.67% | 0.80% | 0.52% |
| *Imports from RW (total for NMS)* | -0.13% | -0.24% | 0.25% | -0.48% | -0.47% | -0.20% | -0.30% | -0.35% |
| *Real Wage Rate* | -0.07% | -0.33% | 0.90% | -1.24% | -1.11% | -1.04% | -0.69% | -1.00% |
| *Relative Consumer Price* | -0.10% | -0.21% | -0.68% | 0.39% | 0.35% | 0.54% | -0.01% | 0.65% |
| *Real Interest Rate* | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% |
| *Terms of Trade* | 0.00% | -0.14% | 0.23% | -0.43% | -0.18% | -0.29% | -0.43% | -0.24% |
| *Public Surplus (% of GDP)** | 0.08% | 0.27% | -0.35% | 0.57% | 0.60% | 0.61% | 0.31% | 0.48% |
| *Current Account (% of GDP)** | 0.04% | 0.17% | -0.31% | 0.37% | 0.40% | 0.49% | 0.20% | 0.35% |
| | | | | | | | | |
| **Total Atmospheric Emissions** | | | | | | | | |
| *CO2 Emissions* | -1.82% | -3.55% | -0.98% | -4.31% | -3.57% | -1.47% | -0.86% | -1.93% |
| *NOX Emissions* | -0.81% | -2.58% | -0.60% | -2.95% | -1.74% | -0.49% | -0.58% | -0.59% |
| *SO2 Emissions* | -5.08% | -4.00% | -1.25% | -4.67% | -5.32% | -4.25% | -3.72% | -5.44% |
| *VOC Emissions* | -0.77% | -5.01% | -0.40% | -8.40% | -3.23% | -2.43% | -1.79% | -2.82% |
| *PM Emissions* | -3.11% | -3.92% | -1.17% | -4.48% | -4.79% | -3.28% | -2.74% | -3.70% |
| **Environmental Policy** | | | | | | | | |
| *Energy Tax (% of GDP)** | 0.09% | 0.29% | -0.42% | 0.67% | 0.71% | 0.65% | 0.37% | 0.56% |
| | | | | | | | | |
| **Welfare** | | | | | | | | |
| *Economic Welfare* | -0.06% | -0.33% | 0.64% | -1.01% | -0.95% | -0.77% | -0.58% | -0.74% |
| *Total Welfare* | 0.01% | -0.12% | 0.65% | -0.84% | -0.73% | -0.73% | -0.45% | -0.65% |
| *Local Benefits (% of GDP)** | 0.06% | 0.17% | 0.01% | 0.12% | 0.17% | 0.04% | 0.10% | 0.07% |

| With recycling through SS contribution | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2010 | | | | |
| **Macroeconomic Aggregates** | Hungary | Poland | Slovenia | Czech Republic | Slovakia | Estonia | Lithuania | Latvia |
| *Gross Domestic Product* | 0.04% | 0.03% | 0.02% | 0.20% | 0.17% | 0.12% | 0.09% | 0.13% |
| *Employment* | 0.14% | 0.39% | 0.05% | 0.54% | 0.62% | 0.30% | 0.49% | 0.53% |
| *Private Consumption* | 0.05% | 0.11% | 0.02% | 0.13% | 0.11% | 0.17% | -0.02% | -0.02% |
| *Investment* | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.05% | 0.03% | 0.04% |
| *Final Energy Consumption* | -1.26% | -2.72% | -0.84% | -4.02% | -2.36% | -1.16% | -0.70% | -0.84% |
| *Share Coal** | -0.49% | -1.30% | -0.46% | -2.18% | -1.16% | -0.57% | -0.17% | -0.33% |
| *Share Oil** | 0.44% | 0.33% | 0.14% | 0.47% | 0.43% | 0.20% | -0.16% | 0.05% |
| *Share Gas** | -0.18% | 0.02% | 0.07% | 0.02% | -0.06% | 0.09% | 0.03% | -0.05% |
| *Share Electricity** | 0.22% | 0.96% | 0.25% | 1.69% | 0.80% | 0.28% | 0.30% | 0.33% |
| *Exports to RW (total for NMS)* | -0.10% | -0.16% | 0.00% | 0.12% | -0.04% | 0.01% | 0.08% | 0.16% |
| *Imports from RW (total for NMS)* | -0.14% | -0.10% | -0.02% | -0.14% | -0.21% | -0.01% | -0.10% | -0.10% |
| *Real Wage Rate* | 0.34% | 0.73% | 0.09% | 0.91% | 1.15% | 0.58% | 0.55% | 0.67% |
| *Relative Consumer Price* | 0.10% | 0.13% | 0.06% | 0.68% | 0.66% | 1.02% | 0.50% | 0.86% |
| *Terms of Trade* | 0.02% | 0.03% | -0.01% | -0.14% | 0.03% | 0.00% | -0.05% | -0.08% |
| *Public Surplus (% of GDP)** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Current Account (% of GDP)** | 0.03% | 0.01% | 0.01% | 0.06% | 0.09% | 0.09% | 0.06% | 0.11% |
| | | | | | | | | |
| **Total Atmospheric Emissions** | | | | | | | | |
| *CO2 Emissions* | -1.83% | -3.47% | -0.93% | -4.11% | -3.42% | -1.14% | -0.69% | -1.69% |
| *NOX Emissions* | -0.82% | -2.53% | -0.60% | -2.76% | -1.72% | -0.37% | -0.41% | -0.51% |
| *SO2 Emissions* | -5.10% | -3.91% | -1.14% | -4.49% | -5.18% | -3.90% | -3.61% | -5.21% |
| *VOC Emissions* | -0.79% | -4.93% | -0.55% | -8.12% | -3.01% | -2.37% | -1.65% | -2.74% |
| *PM Emissions* | -3.17% | -3.83% | -1.08% | -4.30% | -4.68% | -3.09% | -2.62% | -3.55% |
| **Environmental Policy** | | | | | | | | |
| *Energy Tax (% of GDP)** | 0.19% | 0.32% | 0.10% | 0.67% | 0.71% | 0.65% | 0.37% | 0.56% |
| *Reduction of Social Security Rate** | 0.56% | 1.29% | 0.27% | 2.08% | 2.31% | 1.61% | 1.72% | 1.88% |
| | | | | | | | | |
| **Welfare** | | | | | | | | |
| *Economic Welfare* | 0.01% | 0.00% | 0.00% | -0.09% | -0.12% | 0.01% | -0.13% | -0.18% |
| *Total Welfare* | 0.08% | 0.20% | 0.01% | 0.06% | 0.09% | 0.05% | -0.01% | -0.09% |
| *Local Benefits (% of GDP)** | 0.06% | 0.16% | 0.01% | 0.11% | 0.17% | 0.04% | 0.10% | 0.07% |

For the sectoral results (Table 12) only the case with recycling through the SS contributions is reproduced hereafter (the other results are given in annex). At sectoral level, the energy intensive sectors are the most affected by the policy with a shift to consumer goods and service sectors and this both for domestic production and exports.

**Table 12: Sectoral impact in the New Member States of the implementation of the minimum energy tax in these countries when recycling through reduction of employers' social security contributions in 2010**
**(% difference compared to reference)**

| **Sectoral Aggregates** | Hungary | Poland | Slovenia | Czech Republic | Slovakia | Estonia | Lithuania | Latvia |
|---|---|---|---|---|---|---|---|---|
| **Domestic Production in Volume** | | | | | | | | |
| *Agriculture* | 0.02% | 0.07% | 0.02% | 0.36% | 0.40% | 0.10% | 0.19% | 0.18% |
| *Energy Production* | -0.64% | -1.18% | -0.42% | -1.07% | -0.86% | -0.27% | -0.24% | -0.40% |
| *Ferrous and non ferrous metals* | -0.34% | -0.59% | -0.37% | -0.55% | -0.93% | -0.06% | 0.00% | -0.10% |
| *Chemical Products* | -0.32% | -0.04% | 0.01% | -0.04% | 0.03% | -0.01% | 0.08% | 0.15% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Other energy intensive* | -0.15% | -0.13% | -0.06% | 0.16% | 0.06% | 0.03% | 0.00% | 0.02% |
| *Electric Goods* | 0.01% | -0.04% | -0.02% | -0.01% | 0.13% | 0.09% | 0.00% | 0.11% |
| *Transport equipment* | -0.03% | 0.01% | 0.04% | -0.35% | -0.16% | -0.48% | -0.34% | -0.41% |
| *Other Equipment Goods* | 0.01% | -0.10% | 0.02% | -0.10% | 0.00% | 0.03% | -0.02% | 0.11% |
| *Consumer Goods Industries* | -0.04% | 0.05% | 0.05% | 0.36% | 0.40% | 0.11% | 0.18% | 0.12% |
| *Construction* | 0.02% | -0.02% | 0.00% | 0.06% | 0.06% | 0.03% | 0.02% | 0.01% |
| *Telecommunication Services* | 0.04% | -0.04% | 0.03% | 0.29% | 0.29% | 0.15% | 0.12% | 0.10% |
| *Transport* | 0.02% | -0.23% | 0.03% | 0.26% | 0.19% | 0.11% | 0.10% | 0.23% |
| *Services of credit and insurances* | 0.03% | 0.20% | 0.02% | 0.14% | 0.10% | 0.25% | 0.05% | -0.05% |
| *Other Market Services* | 0.03% | 0.05% | 0.03% | 0.04% | 0.09% | 0.12% | 0.02% | 0.04% |
| *Non Market Services* | 0.11% | 0.03% | 0.01% | 0.21% | 0.20% | 0.04% | 0.02% | 0.04% |
| **Exports in Volume** | | | | | | | | |
| *Agriculture* | 0.03% | -0.21% | 0.06% | 0.29% | 0.40% | -0.09% | -0.02% | -0.14% |
| *Energy Exports* | -0.03% | -0.20% | 0.01% | -0.83% | -0.36% | -0.07% | 0.04% | 0.02% |
| *Ferrous and non ferrous metals* | -0.43% | -0.85% | -0.53% | -0.84% | -1.20% | -0.06% | 0.02% | -0.10% |
| *Chemical Products* | -0.49% | -0.05% | 0.01% | -0.25% | -0.12% | -0.03% | 0.05% | 0.15% |
| *Other energy intensive* | -0.33% | -0.20% | -0.12% | 0.33% | 0.14% | -0.01% | 0.03% | 0.07% |
| *Electric Goods* | 0.03% | 0.05% | 0.04% | 0.09% | 0.28% | 0.08% | 0.11% | 0.18% |
| *Transport equipment* | -0.03% | -0.01% | 0.04% | 0.18% | 0.19% | -0.05% | 0.08% | 0.09% |
| *Other Equipment Goods* | 0.05% | 0.04% | 0.04% | 0.26% | 0.27% | 0.02% | 0.06% | 0.19% |
| *Consumer Goods Industries* | -0.10% | -0.01% | 0.06% | 0.37% | 0.57% | -0.01% | 0.12% | 0.11% |
| *Construction* | 0.01% | 0.01% | 0.04% | 0.39% | 0.32% | -0.01% | 0.27% | 0.17% |
| *Telecommunication Services* | 0.07% | 0.00% | - | 0.46% | 0.55% | -0.13% | 0.18% | 0.13% |
| *Transport* | 0.03% | -0.45% | 0.09% | 0.44% | 0.30% | 0.10% | 0.19% | 0.27% |
| *Services of credit and insurances* | 0.11% | 0.25% | 0.07% | 0.37% | 0.38% | -0.08% | 0.20% | -0.04% |
| *Other Market Services* | 0.00% | 0.00% | 0.05% | 0.21% | 0.08% | -0.02% | 0.07% | 0.12% |
| *Non Market Services* | 0.08% | 0.25% | 0.06% | 0.20% | 0.40% | 0.04% | 0.16% | 0.12% |
| **Price of Exports rel. to EU average** | | | | | | | | |
| *Agriculture* | -0.01% | 0.16% | -0.03% | -0.16% | -0.21% | 0.07% | 0.02% | 0.11% |
| *Ferrous and non ferrous metals* | 0.18% | 0.37% | 0.22% | 0.37% | 0.53% | 0.01% | -0.03% | 0.03% |
| *Chemical Products* | 0.23% | 0.03% | 0.00% | 0.13% | 0.08% | 0.03% | -0.02% | -0.06% |
| *Other energy intensive* | 0.15% | 0.09% | 0.05% | -0.15% | -0.06% | 0.00% | -0.01% | -0.03% |
| *Electric Goods* | -0.01% | -0.02% | -0.02% | -0.03% | -0.14% | -0.04% | -0.05% | -0.09% |
| *Transport equipment* | 0.01% | 0.00% | -0.01% | -0.10% | -0.13% | 0.00% | -0.03% | -0.10% |
| *Other Equipment Goods* | -0.02% | -0.02% | -0.02% | -0.11% | -0.14% | -0.01% | -0.02% | -0.08% |
| *Consumer Goods Industries* | 0.05% | 0.01% | -0.02% | -0.13% | -0.19% | 0.01% | -0.05% | -0.02% |
| *Construction* | 0.03% | 0.02% | 0.01% | -0.24% | -0.18% | 0.04% | -0.16% | -0.08% |
| *Telecommunication Services* | -0.04% | 0.01% | -0.04% | -0.31% | -0.34% | 0.10% | -0.11% | -0.08% |
| *Transport* | -0.04% | 0.22% | -0.06% | -0.23% | -0.16% | -0.05% | -0.10% | -0.13% |
| *Services of credit and insurances* | -0.08% | -0.17% | -0.08% | -0.30% | -0.27% | 0.08% | -0.14% | 0.04% |
| *Other Market Services* | -0.03% | -0.14% | -0.05% | -0.21% | -0.16% | 0.06% | -0.04% | -0.08% |
| *Non Market Services* | 0.04% | -0.20% | 0.08% | -0.17% | -0.37% | 0.11% | -0.10% | -0.02% |

This scenario with the minimum energy taxation implemented in all EU countries is used as the reference scenario for the evaluation of the following scenarios, the choice of recycling strategy depending on the policy scenario evaluated.

## 4.2. Upgrading the minimum tax proposal (scenario 2)

### *4.2.1. Assumptions*

The levels of the minimum taxes in the directive remaining rather low, this scenario assumes a gradual upwards adjustment of these rates to take into account the EU climate policy goals. The higher rates would be applied in the whole EU, inclusive the new Member States, above the minimum rates. The national taxes continue to be applied if they are higher than the upgraded minimum tax.

The setting of the scenario is similar to the one built in the previous energy tax study. To increase the "environmental friendliness" of energy taxation, the minimum rates are made dependent on the carbon content of the energy product and their level are increased so that it would correspond in 2010 to 10€/t of CO2. The choice of this level is arbitrary as such, but could be justified on the ground that it is a bit lower than the estimates of marginal CO2 abatement costs associated with the EU Kyoto target, obtained in model simulations (CAFE simulations with the PRIMES model).

The structure of the rates for different energy products corresponding to these two target levels is displayed in the table below, also showing the current level of EU minimum rates for the sake of comparison.

**Table 13: The level of tax rates for different energy products corresponding to a carbon tax of 10€/t.**

| | 10€/tCO2 | EU minimum rates 2004 | |
|---|---|---|---|
| **Energy product** | €/GJ | €/GJ | €/Phys. unit |
| Coal | 0.97 | 0.15-0.30 | 0.15-0.3/GJ |
| Heavy fuel oil | 0.77 | 0.37 | 15/ton |
| Light fuel oil/gas oil | 0.73 | 0.58 | 21/1000 l |
| Natural gas | 0.56 | 0.15 | 0.15-0.3/GJ |
| Petrol | 0.69 | 10.27 | 359/1000 l |
| Diesel | 0.73 | 8.10 | 302-330 /1000 l |
| Electricity | 1.18 | 0.14 | 0.5 -1.0/MWh |

The rate on electricity is computed taking into account the CO2 emissions of the electricity sector and the electricity production in 2000 in the EU according to EUROSTAT statistics. It reflects the EU average fuel use for electricity production.

The EU energy taxes are output taxes in the scenario in the sense that only the final use of energy is taxed. This means that energy products used to produce electricity are not taxed, but only final electricity consumption. Neither any non-energy use energy products is taxed. Such a tax provides incentives for the improvements in energy efficiency but not for CO2 reduction in the energy transformation sector.

Again, two possibilities for the revenue recycling are considered:

1. the revenues are used to decrease the public deficit which alleviates the financial constraint of private economic agents and reduces the interest rate.
2. the revenues are recycled through a decrease of the social security contributions.

### *4.2.2. Results for the EU*

The results at EU level for the scenario are given in Table 14, detailed results by country are given in annex. Though the tax slightly reduces the EU exports, the recycling of the tax revenue through SS contribution has a positive effect on employment and private consumption. With this level of the tax,

the CO2 emissions are reduced by 4% compared to the reference[7], while the Kyoto target imposes a reduction of 14% for EU15 given the reference used in this exercise. The mechanism at play is the same as in the minimum tax scenario: the cost increase through the energy tax is partly compensated by the reduction in the social security rate and this limits the impact of this measure on domestic and foreign demand. It is important to remember that in most countries and sectors, the intra-EU exports represent more than 50% of total exports and this limits the negative effect of the export price increase when a harmonised policy is implemented in the EU.

The recycling strategy imposed in this scenario is important for the results. The reduction of the SS contributions by reducing the labour cost allows limiting the price increase due to the energy tax. It has also a positive effect on the real wage and hence on labour income and private consumption and hence a positive impact on welfare. This is not the case when no specific recycling strategy is imposed, the impact on the interest rate remaining very small and does not allow to compensate for the increased energy cost through its impact on investment and consumption.

The impact is greater in the new Member States as the level of energy taxation remain lower there than in most EU15 countries, even with the implementation of the minimum tax. The reduction in CO2 emissions in the New Member States varies between 4 and 12%, compared to an average of 2% in EU15.

In terms of overall welfare, the policy measure is slightly positive, mostly in the New Member States, when recycling the revenue through a reduction of the SS rate, as this policy measure allows a reduction in the labour market distortion. The positive impact goes mainly through an increased private consumption.

**Table 14: Macroeconomic impact at EU level (22countries) of upgrading the minimum energy tax to an equivalent of 10 € per ton CO2**
**(% difference compared to reference, except for * where difference)**

| | without direct recycling of tax revenue | | | with SS recycling of tax revenue | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2010 | 2020 | 2030 |
| **Macroeconomic Aggregates** | | | | | | |
| *Gross Domestic Product* | -0.04% | -0.05% | -0.06% | 0.01% | 0.00% | -0.01% |
| *Employment* | 0.00% | -0.02% | -0.02% | 0.25% | 0.22% | 0.19% |
| *Private Consumption* | -0.03% | -0.04% | -0.05% | 0.07% | 0.06% | 0.05% |
| *Investment* | -0.03% | -0.04% | -0.05% | -0.02% | -0.02% | -0.03% |
| *Final Energy Consumption* | -1.18% | -1.20% | -1.20% | -1.12% | -1.12% | -1.12% |
| *Share Coal** | -1.15% | -1.12% | -1.05% | -1.14% | -1.10% | -1.03% |
| *Share Oil** | 0.59% | 0.54% | 0.49% | 0.57% | 0.53% | 0.48% |
| *Share Gas** | 0.16% | 0.16% | 0.15% | 0.16% | 0.16% | 0.14% |
| *Share Electricity** | 0.40% | 0.41% | 0.41% | 0.40% | 0.42% | 0.41% |
| *Exports to RW* | -0.14% | -0.15% | -0.15% | -0.14% | -0.14% | -0.13% |
| *Imports from RW* | -0.07% | -0.06% | -0.05% | -0.02% | -0.02% | -0.02% |
| *Real Wage Rate* | 0.04% | 0.03% | 0.02% | 0.14% | 0.12% | 0.09% |
| *Relative Consumer Price* | 0.00% | 0.02% | 0.04% | -0.02% | 0.00% | 0.01% |
| *Real Interest Rate* | -0.10% | -0.10% | -0.10% | 0.00% | 0.00% | 0.00% |
| *Terms of Trade* | 0.10% | 0.11% | 0.09% | 0.16% | 0.13% | 0.11% |
| *Current Account (% of GDP)** | 0.00% | 0.00% | 0.00% | -0.01% | -0.01% | -0.01% |
| | | | | | | |
| **Total Atmospheric Emissions** | | | | | | |
| *CO2 Emissions* | -3.55% | -3.64% | -3.64% | -3.49% | -3.56% | -3.55% |
| *NOX Emissions* | -2.25% | -2.28% | -2.27% | -2.20% | -2.22% | -2.20% |

[7] With the minimum tax implemented in all EU countries

| | | | | | | |
|---|---|---|---|---|---|---|
| *SO2 Emissions* | -5.82% | -6.00% | -6.04% | -5.74% | -5.89% | -5.92% |
| *VOC Emissions* | -3.79% | -3.86% | -3.91% | -3.72% | -3.77% | -3.81% |
| *PM Emissions* | -5.18% | -5.33% | -5.36% | -5.09% | -5.20% | -5.21% |
| **Environmental Policy** | | | | | | |
| *Energy Tax (% of GDP)** | 0.14% | 0.12% | 0.11% | 0.14% | 0.13% | 0.11% |
| *Reduction of Social Security Rate** | 0.00% | 0.00% | 0.00% | 0.96% | 0.86% | 0.77% |
| | | | | | | |
| **Welfare** | | | | | | |
| *Economic Welfare* | -0.04% | -0.04% | -0.05% | 0.03% | 0.02% | 0.02% |
| *Total Welfare* | 0.03% | 0.02% | 0.01% | 0.10% | 0.09% | 0.08% |
| *Local Benefits (% of GDP)** | 0.05% | 0.05% | 0.04% | 0.05% | 0.05% | 0.04% |

At sectoral level, the energy intensive sectors and especially those using coal, are the most affected by the policy both in terms of production and exports, though the impact remains small. In some sectors and countries, the prices can even decrease through the interactions of demand and supply in the labour and good market and their impact on production factors cost. The choice of recycling strategy has less impact on the energy intensive sectors than on the other sectors because the relative cost of the energy tax is higher compared to the benefits of the reduction of the social security contribution.

**Table 15: Sectoral impact at EU level (22 countries) of upgrading the minimum energy tax to an equivalent of 10 € per ton CO2**
**(% difference compared to reference)**

| | without direct recycling of tax revenue | | | with SS recycling of tax revenue | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2010 | 2020 | 2030 |
| **Domestic Production in Volume** | | | | | | |
| *Agriculture* | -0.04% | -0.08% | -0.10% | 0.05% | 0.05% | 0.04% |
| *Energy Production* | -0.96% | -1.00% | -1.02% | -0.91% | -0.93% | -0.94% |
| *Ferrous and non ferrous metals* | -0.62% | -0.63% | -0.62% | -0.60% | -0.61% | -0.60% |
| *Chemical Products* | -0.22% | -0.26% | -0.28% | -0.19% | -0.21% | -0.22% |
| *Other energy intensive* | -0.27% | -0.29% | -0.30% | -0.25% | -0.26% | -0.26% |
| *Electric Goods* | -0.12% | -0.12% | -0.12% | -0.05% | -0.05% | -0.05% |
| *Transport equipment* | -0.09% | -0.10% | -0.11% | -0.03% | -0.05% | -0.05% |
| *Other Equipment Goods* | -0.14% | -0.14% | -0.14% | -0.08% | -0.07% | -0.07% |
| *Consumer Goods Industries* | -0.03% | -0.05% | -0.07% | 0.03% | 0.02% | 0.02% |
| *Construction* | -0.04% | -0.05% | -0.05% | -0.02% | -0.03% | -0.03% |
| *Telecommunication Services* | 0.01% | -0.01% | -0.01% | 0.04% | 0.03% | 0.02% |
| *Transport* | -0.04% | -0.06% | -0.07% | -0.01% | -0.02% | -0.03% |
| *Services of credit and insurances* | -0.01% | -0.02% | -0.02% | 0.02% | 0.01% | 0.01% |
| *Other Market Services* | -0.01% | -0.01% | -0.02% | 0.03% | 0.02% | 0.01% |
| *Non Market Services* | -0.01% | -0.01% | -0.01% | 0.02% | 0.02% | 0.02% |
| **Exports in Volume** | | | | | | |
| *Agriculture* | 0.08% | 0.05% | 0.03% | 0.05% | 0.03% | 0.02% |
| *Energy Exports* | -0.30% | -0.33% | -0.33% | -0.31% | -0.31% | -0.31% |
| *Ferrous and non ferrous metals* | -1.15% | -1.15% | -1.14% | -1.15% | -1.15% | -1.15% |
| *Chemical Products* | -0.32% | -0.36% | -0.39% | -0.30% | -0.32% | -0.34% |
| *Other energy intensive* | -0.41% | -0.43% | -0.44% | -0.44% | -0.45% | -0.46% |
| *Electric Goods* | -0.10% | -0.11% | -0.11% | -0.04% | -0.04% | -0.03% |
| *Transport equipment* | -0.12% | -0.13% | -0.13% | -0.06% | -0.07% | -0.07% |
| *Other Equipment Goods* | -0.16% | -0.16% | -0.16% | -0.07% | -0.07% | -0.06% |
| *Consumer Goods Industries* | 0.04% | 0.01% | -0.01% | 0.02% | 0.00% | -0.02% |
| *Construction* | 0.99% | 0.83% | 0.74% | 0.00% | 0.03% | 0.05% |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Telecommunication Services* | 0.24% | 0.19% | 0.15% | 0.14% | 0.11% | 0.08% |
| *Transport* | -0.03% | -0.05% | -0.07% | -0.04% | -0.05% | -0.07% |
| *Services of credit and insurances* | 0.16% | 0.12% | 0.09% | 0.14% | 0.12% | 0.10% |
| *Other Market Services* | 0.03% | 0.01% | -0.01% | 0.04% | 0.03% | 0.02% |
| *Non Market Services* | 0.41% | 0.34% | 0.29% | 0.21% | 0.17% | 0.13% |
| **Price of Exports** | | | | | | |
| *Agriculture* | -0.11% | -0.08% | -0.05% | -0.03% | -0.01% | 0.01% |
| *Ferrous and non ferrous metals* | 0.80% | 0.77% | 0.75% | 0.81% | 0.79% | 0.78% |
| *Chemical Products* | 0.17% | 0.19% | 0.20% | 0.17% | 0.18% | 0.19% |
| *Other energy intensive* | 0.29% | 0.29% | 0.29% | 0.35% | 0.34% | 0.32% |
| *Electric Goods* | 0.03% | 0.04% | 0.04% | 0.01% | 0.01% | 0.01% |
| *Transport equipment* | 0.08% | 0.08% | 0.08% | 0.06% | 0.06% | 0.04% |
| *Other Equipment Goods* | 0.07% | 0.07% | 0.06% | 0.03% | 0.03% | 0.02% |
| *Consumer Goods Industries* | -0.04% | -0.02% | -0.01% | 0.00% | 0.01% | 0.03% |
| *Construction* | -0.73% | -0.62% | -0.57% | -0.01% | -0.02% | -0.05% |
| *Telecommunication Services* | -0.21% | -0.15% | -0.12% | -0.11% | -0.08% | -0.07% |
| *Transport* | -0.05% | -0.01% | 0.00% | -0.02% | 0.00% | 0.01% |
| *Services of credit and insurances* | -0.14% | -0.11% | -0.09% | -0.12% | -0.10% | -0.09% |
| *Other Market Services* | -0.11% | -0.08% | -0.05% | -0.09% | -0.06% | -0.06% |
| *Non Market Services* | -0.72% | -0.58% | -0.48% | -0.34% | -0.27% | -0.22% |

## 4.3. The 'professional diesel/non professional' proposal

The minimum tax rate policies as evaluated in the previous sections are aiming at the harmonisation of the energy taxation between Member States. The proposal regarding 'professional diesel' is more specific: by making a distinction between diesel used for professional and for non professional uses in transport, it aims at equalizing the minimum rate on non-professional diesel with the minimum rate on petrol as there are no environmental/energy justification to apply a lower rate for diesel for that use.

Though a macroeconomic general equilibrium model as GEM-E3 is already sectorally rather detailed, the policy measure is rather too much sector specific to imply aggregate macroeconomic impacts. Moreover equalizing the minimum rate of diesel to the rate on petrol has only an impact on the cost of transport for households in a small number of countries, as the tax rates on fuels are higher than the minimum tax rates in most countries. Also the impact depends on the share of diesel in household transport. The shares used in GEM-E3 (for the computation of the average tax rate for households) are derived from the TREMOVE model and are reproduced in the table hereafter. For the new Member States the same data were not available from TREMOVE, but based on other data available we assumed a share of 90% for petrol. This assumption implies that the equalizing of the tax on petrol and diesel will not have a great impact in these countries.

**Table 16: Share of petrol and diesel in household's consumption for transport**
**(source: TREMOVE model and own computation)**

| | petrol | diesel |
|---|---|---|
| AT | 68% | 32% |
| BE | 64% | 36% |
| DE | 85% | 15% |
| DK | 94% | 6% |
| FI | 93% | 7% |
| FR | 73% | 27% |
| EL | 94% | 6% |
| IE | 92% | 9% |

| | | |
|---|---|---|
| IT | 76% | 24% |
| NL | 69% | 31% |
| PT | 82% | 18% |
| ES | 79% | 21% |
| SE | 97% | 3% |
| UK | 92% | 8% |

At macroeconomic level, the simulated impacts are not significant. At microeconomic level, the measure will have an impact on the choice about the purchase of a diesel or a petrol vehicle but the aggregation level of GEM-E3 (as most General Equilibrium models) does not allow the examination of this kind of decisions.

## 4.4. Energy taxation policies with climate policies (scenario 3, 4 and 5)

The objective of these scenarios is to examine how the energy taxation policy can contribute to the EU climate objective. To this end we consider one climate policy to combine with various energy taxation policies. For the climate policy we distinguish between the Kyoto commitment period for which an emission reduction target exists and the post-2012 period for which no target is yet specified. Regarding the first commitment period, we assume that the EU allowance trading scheme for energy intensive sectors (EU directive COM(2003)87) is implemented from 2005 onwards and it is complemented between 2008 and 2012 with a domestic CO2 tax for the sectors not participating in the EU allowance scheme. For the period after 2012 (2013-2030), a gradually increasing EU wide carbon tax is considered with two levels, 25€ and 45€ per ton of CO2 in 2030. The energy taxation policies considered are either the minimum rates as in scenario 1 or the upgraded rates as in scenario 2, combined with various schemes of exemption for the energy intensive sectors.

As already said before, the reference is the scenario with minimum tax in EU15 and in the new Member States (scenario 1). Only the recycling strategy through the reduction of the social security contribution is considered as it is more efficient and the impact of the recycling strategy has been examined with the previous scenarios.

### *4.4.1. Assumptions for the climate policy*

#### a) The first commitment period

Regarding climate policy, the scenario assumes that all the countries fulfil their individual Kyoto target in accordance with the Burden Sharing Agreement with the targets expressed in terms of CO2 emissions using the same methodology as in the previous study (ECOFYS estimates). This implicitly assumes that the relative CO2 versus other GHG reduction cost does not change with the baseline. The reduction targets are given in the next table. For the New Member States we used as CO2 reduction target their Kyoto target. However for those countries where the reference emissions are lower than their target, i.e. when there is 'Hot Air', we assumed that the 'Hot Air' is frozen as there is still no decision regarding this issue. This assumption has clearly an impact on our results (increasing the cost of reaching the Kyoto target) but it allows better to evaluate the contribution of the energy taxation policies.

**Table 17: Kyoto reduction target for 2010**

| | All GHG (burden sharing agreement) wrt 1990 | CO2 (ECOFYS study with small adaptation) wrt 1990 | CO2 (ECOFYS study with small adaptation) wrt to 2010 in GEM-E3 reference |
|---|---|---|---|
| AT | -13.0% | -18.2% | -41.49% |
| BE | -7.5% | -6.9% | -23.5% |
| DE | -21.0% | -19.4% | -4.4% |

| | | | |
|---|---|---|---|
| DK | -21.0% | -23.2% | -34.1% |
| FI | 0.0% | 4.8% | -7.3% |
| FR | 0.0% | 6.8% | -2.9% |
| EL | 25.0% | 37.2% | 6.4% |
| IE | 13.0% | 20.7% | -24.4% |
| IT | -6.5% | -6.1% | -9.8% |
| NL | -6.0% | 4.3% | -17.4% |
| PT | 27.0% | 49.6% | -15.1% |
| ES | 15.0% | 26.7% | -5.2% |
| SE | 4.0% | 4.5% | -6.2% |
| UK | -12.5% | -9.7% | -10.2% |

The EU CO2 emission allowance trading scheme is implemented in the whole EU, including the New Member States, from 2005 onwards, in accordance with the Directive COM(2003)87. The following energy intensive sectors are participating: electricity (NACE-CLIO 097) and heat generators, ferrous and non ferrous ore and metals (NACE-CLIO 13) and other energy intensive sectors, covering non metallic mineral products (NACE-CLIO 15), metal products except machinery and transport equipment (NACE-CLIO 19) and paper and printing products (NACE-CLIO 47). This has been applied to GEM-E3 sectors: electricity and heat generators, ferrous and non-ferrous ore and metals and "other energy-intensive sectors" (including non-metallic mineral products, metal products except machinery and transport equipment, and paper and printing products).

For the trading scheme, the initial allocation of allowances in a country is based on an "efficient allocation", which implicitly equalizes the marginal abatement costs across sectors in the country. The initial allowances are allocated to the sectors free of charge and it is assumed that the rent obtained by the firms through this allocation is distributed as capital income. As the directive allows the auctioning of a maximum of 10% of the allowance, this possibility is also considered in a separate scenario. The reduction target in 2005 for the sectors participating in the trading scheme has been assumed to be 30% of their 2010 target.

For 2010 when the Kyoto target is binding, a domestic carbon tax is imposed on the sectors that are not covered by the allowance trading scheme, with the level of the tax determined endogenously such as to reach the national CO2 target as defined above, given the allowances allocated to the energy intensive sectors. As by the way the scenario is set up the domestic target on the sectors not participating in the trading scheme and the global target on the EU allowance market are fixed ex-ante and the possibility of shifting the effort between the two segments within one country is not possible, another set of scenarios was considered in which the public sector can also be active on the allowance trading scheme. This greater flexibility for CO2 reduction limits the spread between the EU allowance scheme and the national domestic tax. The possibilities of using JI/CDM credits are not considered.

### b) The period 2013-2030

No commitments have been yet made for the period after 2012, which renders the definition of a climate policy rather difficult. As the objective is not to examine the impact of different climate policies but to concentrate on energy taxation policies, a rather simple set-up has been defined, assuming an EU wide CO2 tax increasing from 19€ per ton of CO2 in 2013 to alternatively 25€ or 45€ in 2030. The tax is applied to all sectors and this uniform carbon tax is equivalent to an EU wide allowance trading scheme with auctioning at national level of the allowances and covering all CO2 emissions in the EU.

## *4.4.2. Assumptions regarding energy tax policy*

The alternatives considered for energy taxation are the following:

1) The energy tax policy is the "reference" scenario (scenario 1), i.e. the EU minimum rates and national rates (if they are higher) are implemented in both trading and non-trading sectors in the whole EU.

2) The energy tax policy as in scenario 2, i.e. the upgraded energy tax (if they are higher), are implemented in both trading and non-trading sectors in the whole EU.

3) The energy tax policy as in scenario 1 or 2, with either full exemption for the sectors participating in the EU trading scheme or with exemption of the CO2 component for those sectors.

The CO2 component is computed based on the allowance price in the EU allowance market in 2010 in the scenario where the trading scheme and the energy tax is applied without exemption and for the period after 2012 it is given by the CO2 tax assumed. For the revenue recycling it is assumed that the tax revenues accruing from the energy taxes and the CO2 tax are used to reduce indirect labour costs (employers' social security contributions), such as to maintain the budget neutrality of the tax reform.

### *4.4.3. The results at EU level*

#### a) The first commitment period

***(1) with the minimum energy tax rates***

*(a) no government participation in trading scheme*

The impact in 2010 at EU level remains limited though higher than in 2005 as the carbon constraint is stronger. The efficient allocation of the CO2 reduction and the revenue recycling strategy limits the negative impact even for countries where the reduction compared to the reference emissions is high.

The gain in employment induced by the policy in 2010 is the highest in the countries with a high decrease in the SS rate and it has then a positive effect on income and private consumption if the domestic tax is not too high. Those countries are also mostly buyers of allowances as their reduction targets are relatively high (e.g. Austria, Belgium, Denmark, Ireland and the Netherlands). Country selling allowances, mostly because of a lower reduction target, benefit from the generated revenue (redistributed as capital income) but less from a reduction social security rate. The impact on relative prices integrates the different influences: the energy tax and the allowance prices push the prices up while the decrease in social security has the reverse effect. There is a shift away from coal and in favour of electricity, which is increasing its share in final energy demand, although in absolute value the demand decreases. Investment demand is decreasing because of the substitution effect towards labour and because of the reduction in demand which both have a negative impact on the rate of return of capital.

For most new Member States the domestic CO2 tax is zero or close to zero because their reduction target in the Kyoto protocol and the assumption for its implementation in these scenarios (no reduction compared to the reference). Their CO2 emissions are reduced because of the selling of emissions allowances which then generates a transfer to these countries which goes to the sectors reducing their emissions and is redistributed within the country. However they do not benefit from a reduction in the social security rate as no domestic tax is imposed. Therefore the employment effect is much lower there.

Auctioning 10% of the allowances, which is the maximum allowed in the EU directive, increases slightly the reduction of the social security contribution because of the generated income. It does not have a significant impact at macroeconomic level compared to the no auction case, because the cost increase for the energy intensive sectors is partially compensated by the higher reduction in social security rate and this reduction is also beneficial for the other sectors.

The exemption for the sectors participating in the allowance scheme either totally or only for the CO2 component has only a very small impact at the macroeconomic level, though it reduces the revenue recycling possibilities. The energy intensive sectors face the same carbon constraint in the different scenarios as there is no possibility of shifting the reduction effort between the sectors in and outside the EU trading scheme. The allowance price increases slightly when the sectors in the trading scheme

are exempted either fully or for the CO2 component only. The benefit from exemption is however larger than the cost of the increase in the allowance price and the smaller reduction in SS rate, inducing a smaller decrease in exports for those sectors. Attributing exemptions to the energy intensive sectors shift the burden of the climate policy to the other sectors.

**Table 18: Macroeconomic impact at EU level (22 countries) with the minimum energy tax as energy policy associated with the climate policy**
**(% difference compared to reference, except for * where difference)**

| | EU allowance system from 2005 | EU allowance system from 2005, plus domestic CO2tax in 2010 | EU allowance system from 2005, plus domestic CO2tax in 2010 | EU allowance system from 2005 with 10% auction in 2010, plus domestic CO2tax in 2010 | EU allowance system from 2005, plus domestic CO2tax in 2010 with exemption of CO2 component in energy tax for EI sectors in | EU allowance system in 2005 and 2010, plus domestic CO2tax in 2010, with exemption of the energy tax for EI sectors |
|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2010 | 2010 | 2010 | 2010 |
| **Macroeconomic Aggregates** | | without direct recycling of tax revenue | with recycling of tax revenue through social security contribution | | | |
| *Gross Domestic Product* | -0.01% | -0.23% | -0.10% | -0.10% | -0.11% | -0.11% |
| *Employment* | -0.02% | -0.12% | 0.12% | 0.15% | 0.09% | 0.06% |
| *Private Consumption* | -0.01% | -0.19% | -0.07% | -0.03% | -0.09% | -0.12% |
| *Investment* | -0.01% | -0.13% | -0.11% | -0.10% | -0.10% | -0.10% |
| *Final Energy Consumption* | -0.40% | -3.80% | -3.75% | -3.74% | -3.66% | -3.45% |
| *Share Coal** | -0.25% | -0.70% | -0.70% | -0.70% | -0.67% | -0.73% |
| *Share Oil** | 0.15% | -0.51% | -0.53% | -0.53% | -0.49% | -0.44% |
| *Share Gas** | 0.02% | -0.13% | -0.13% | -0.13% | -0.12% | -0.16% |
| *Share Electricity** | 0.08% | 1.34% | 1.36% | 1.36% | 1.28% | 1.33% |
| *Exports to RW* | -0.07% | -0.86% | -0.56% | -0.64% | -0.52% | -0.47% |
| *Imports from RW* | -0.06% | -0.43% | -0.47% | -0.42% | -0.49% | -0.51% |
| *Real Wage Rate* | -0.03% | -0.33% | 0.29% | 0.33% | 0.22% | 0.15% |
| *Relative Consumer Price* | 0.02% | 0.29% | 0.22% | 0.26% | 0.22% | 0.25% |
| *Real Interest Rate* | 0.00% | -0.31% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Terms of Trade* | 0.08% | 1.10% | 0.61% | 0.77% | 0.55% | 0.47% |
| *Current Account (% of GDP)** | -0.01% | 0.00% | 0.02% | 0.01% | 0.03% | 0.03% |
| | | | | | | |
| **Total Atmospheric Emissions** | | | | | | |
| *CO2 Emissions* | -2.60% | -12.53% | -12.54% | -12.53% | -12.54% | -12.54% |
| *NOX Emissions* | -2.41% | -12.65% | -12.66% | -12.66% | -12.77% | -12.64% |
| *SO2 Emissions* | -4.89% | -16.74% | -16.75% | -16.74% | -17.38% | -17.50% |
| *VOC Emissions* | -0.33% | -7.83% | -7.82% | -7.81% | -7.71% | -7.53% |
| *PM Emissions* | -5.05% | -17.26% | -17.28% | -17.27% | -18.24% | -18.41% |
| **Environmental Policy** | | | | | | |
| *Energy Tax (% of GDP)** | 0.00% | -0.07% | -0.07% | -0.07% | -0.10% | -0.13% |
| *Environmental Tax (% of GDP)** | 0.00% | 0.47% | 0.48% | 0.48% | 0.48% | 0.48% |
| *Reduction of Social Security Rate** | 0.00% | 0.00% | 0.72% | 0.85% | 0.61% | 0.51% |

| | | | | | | |
|---|---|---|---|---|---|---|
| *CO2 marginal abatement cost (Euro95/tn CO2)*[8] | 3.02 | 18.97 | 19.12 | 19.12 | 19.66 | 19.85 |
| *CO2 marginal abatement cost ,EU (Euro95/tn CO2)*[9] | 3.02 | 12.68 | 12.76 | 12.76 | 13.93 | 14.37 |
| *CO2 marginal abatement cost ,domestic (Euro95/tn CO2)*[10] | | 23.53 | 23.71 | 23.71 | 23.78 | 23.78 |
| | | | | | | |
| **Welfare** | | | | | | |
| *Economic Welfare* | 0.00% | -0.15% | -0.13% | -0.09% | -0.14% | -0.16% |
| *Total Welfare* | 0.06% | 0.11% | 0.13% | 0.17% | 0.13% | 0.11% |
| *Local Benefits (% of GDP)** | 0.05% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% |

At sectoral level, the EU trading scheme as implemented in these scenarios with no transfer possibilities between the trading and not trading sectors, is relatively favourable to the energy intensive sectors participating in the trading because the allowance price is lower than the domestic tax as the EU allowance trading market benefits from the abatement possibilities available in the new Member States. The two exemption schemes evaluated here reinforce this effect because the sectors in the trading scheme benefit from the exemption while all sectors have the negative impact of a lower reduction in the social security contribution.

**Table 19: Sectoral impact at EU level with the minimum energy tax as energy policy associated with the climate policy in 2010**
**(% difference compared to reference)**

| | EU allowance system from 2005 | EU allowance system plus domestic CO2tax in 2010 | EU allowance sysstem plus domestic CO2tax in 2010 | EU allowance system with 10% auction in 2010, plus domestic CO2tax in 2010 | EU allowance system plus domestic CO2tax in 2010 with exemption of CO2 component in energy tax for EI sectors | EU allowance system plus domestic CO2tax in 2010, with exemption of the energy tax for EI sectors |
|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2010 | 2010 | 2010 | 2010 |
| **Sectoral Aggregates** | | without direct recycling of tax revenue | with SS recycling of tax revenue | | | |
| **Domestic Production in Volume** | | | | | | |
| *Agriculture* | -0.01% | -0.27% | -0.23% | -0.22% | -0.24% | -0.26% |
| *Energy Production* | -0.59% | -4.69% | -4.65% | -4.64% | -4.57% | -4.38% |
| *Ferrous and non ferrous metals* | -0.22% | -0.96% | -0.79% | -0.82% | -0.66% | -0.46% |
| *Chemical Products* | -0.04% | -0.71% | -0.55% | -0.57% | -0.55% | -0.56% |
| *Other energy intensive* | -0.13% | -0.62% | -0.49% | -0.50% | -0.38% | -0.14% |
| *Electric Goods* | -0.04% | -0.39% | -0.15% | -0.18% | -0.14% | -0.13% |
| *Transport equipment* | -0.04% | -0.44% | -0.23% | -0.24% | -0.22% | -0.21% |
| *Other Equipment Goods* | -0.05% | -0.35% | -0.15% | -0.17% | -0.13% | -0.12% |
| *Consumer Goods Industries* | -0.02% | -0.32% | -0.21% | -0.21% | -0.22% | -0.23% |
| *Construction* | -0.01% | -0.15% | -0.11% | -0.10% | -0.11% | -0.10% |
| *Telecommunication Services* | 0.00% | -0.07% | 0.04% | 0.05% | 0.02% | 0.01% |
| *Transport* | -0.02% | -1.07% | -0.92% | -0.93% | -0.93% | -0.94% |
| *Services of credit and insurances* | 0.00% | -0.08% | 0.02% | 0.02% | 0.01% | 0.00% |
| *Other Market Services* | 0.00% | -0.13% | -0.03% | -0.01% | -0.04% | -0.05% |

[8] The CO2 marginal abatement cost is the average price for a ton of CO2, the price being either the allowance price on the EU trading market or the domestic tax depending on the sector

[9] The CO2 marginal abatement cost, EU, is the allowance price on the EU trading market

[10] The CO2 marginal abatement cost, domestic, is the domestic CO2 tax

| | | | | | | |
|---|---|---|---|---|---|---|
| *Non Market Services* | 0.00% | -0.01% | 0.00% | 0.01% | 0.00% | -0.01% |
| **Exports in Volume** | | | | | | |
| *Agriculture* | 0.01% | -0.47% | -0.52% | -0.55% | -0.54% | -0.55% |
| *Energy Exports* | -0.35% | -4.57% | -4.53% | -4.55% | -4.40% | -4.32% |
| *Ferrous and non ferrous metals* | -0.41% | -1.71% | -1.42% | -1.48% | -1.16% | -0.78% |
| *Chemical Products* | -0.06% | -1.03% | -0.81% | -0.87% | -0.82% | -0.83% |
| *Other energy intensive* | -0.21% | -0.98% | -0.77% | -0.82% | -0.57% | -0.15% |
| *Electric Goods* | -0.05% | -0.45% | -0.10% | -0.15% | -0.09% | -0.09% |
| *Transport equipment* | -0.06% | -0.59% | -0.28% | -0.32% | -0.26% | -0.24% |
| *Other Equipment Goods* | -0.06% | -0.44% | -0.11% | -0.16% | -0.09% | -0.08% |
| *Consumer Goods Industries* | -0.02% | -0.62% | -0.48% | -0.54% | -0.49% | -0.51% |
| *Construction* | 0.01% | -0.47% | -0.07% | -0.22% | -0.07% | -0.06% |
| *Telecommunication Services* | 0.04% | -0.12% | 0.17% | 0.11% | 0.15% | 0.11% |
| *Transport* | -0.02% | -2.26% | -2.03% | -2.09% | -2.03% | -2.05% |
| *Services of credit and insurances* | 0.04% | -0.02% | 0.29% | 0.22% | 0.27% | 0.26% |
| *Other Market Services* | 0.00% | -0.19% | 0.02% | -0.02% | 0.02% | 0.02% |
| *Non Market Services* | 0.03% | -0.18% | 0.06% | 0.02% | 0.02% | -0.01% |
| **Price of Exports** | | | | | | |
| *Agriculture* | -0.02% | 0.36% | 0.49% | 0.53% | 0.49% | 0.50% |
| *Ferrous and non ferrous metals* | 0.29% | 1.10% | 0.92% | 0.96% | 0.72% | 0.46% |
| *Chemical Products* | 0.03% | 0.54% | 0.42% | 0.46% | 0.42% | 0.43% |
| *Other energy intensive* | 0.17% | 0.70% | 0.54% | 0.58% | 0.37% | 0.01% |
| *Electric Goods* | 0.02% | 0.17% | -0.02% | 0.01% | -0.03% | -0.03% |
| *Transport equipment* | 0.03% | 0.30% | 0.12% | 0.15% | 0.10% | 0.09% |
| *Other Equipment Goods* | 0.03% | 0.18% | -0.01% | 0.02% | -0.02% | -0.03% |
| *Consumer Goods Industries* | 0.01% | 0.32% | 0.25% | 0.29% | 0.25% | 0.26% |
| *Construction* | -0.01% | 0.34% | 0.04% | 0.16% | 0.04% | 0.03% |
| *Telecommunication Services* | -0.04% | 0.07% | -0.16% | -0.10% | -0.15% | -0.11% |
| *Transport* | -0.01% | 1.52% | 1.37% | 1.42% | 1.38% | 1.41% |
| *Services of credit and insurances* | -0.03% | -0.03% | -0.28% | -0.22% | -0.26% | -0.25% |
| *Other Market Services* | -0.03% | -0.05% | -0.17% | -0.13% | -0.17% | -0.15% |
| *Non Market Services* | -0.06% | 0.30% | -0.10% | -0.03% | -0.05% | 0.00% |

### *(b) With government participating in trading scheme*

In the previous scenarios, the distribution of the burden of the reduction between the sectors in and out of the trading scheme was fixed ex-ante without the possibility of shifting the effort between the two segments within one country. In the scenarios presented here flexibility in the distribution of the burden is introduced by allowing the government to participate in the allowance trading scheme. It is assumed that the government will intervene such as to equalize the marginal abatement cost over all sectors. This maybe overestimates the possible flexibility in reducing CO2 emissions but illustrates the impact it can have.

The greater flexibility for CO2 reduction limits the spread between the EU allowance price and the national domestic tax and makes the low cost reduction possibilities in the sectors not participating in the EU scheme in the New Member States available. In the former EU countries it shifts the burden from the domestic consumers to the energy intensive sectors and the ROW through the export prices compared to the previous scenarios. This is reflected in the macroeconomic impact: private consumption is increasing while the negative impact on the exports is increased. The impact on the current account remains limited because of positive terms of trade effect. This overall positive effect at EU level is mostly reflecting the impact on the New Member States. They are the main gainer in these scenarios because of the increase in the price of the allowance in the EU trading scheme and the possibility of selling through the government more allowances by reducing emissions in the sectors not participating in the trading scheme. It has a positive effect on their economic activity and hence on

employment and private consumption, all this is reinforced by the greater reduction in the social security rate it allows because of the transfers to their government. In the other EU countries the impact is less pronounced though there is still a shift in favour of domestic consumers not participating in the EU trading scheme because they benefit from the reduction in their domestic CO2 tax.

As the allocation of the reduction between countries is changed compared to the previous scenarios, the reduction in final energy consumption is smaller but more concentrated in coal.

**Table 20: Macroeconomic impact at EU level (22 countries) with the minimum energy tax as energy policy associated with the climate policy in 2010**
**(% difference compared to reference, except for * where difference)**

| | EU allowance system plus domestic CO2tax | EU allowance system plus domestic CO2tax in 2010 with government in EU trading scheme | EU allowance system plus domestic CO2tax with exemption of CO2 component in energy tax for EI sectors and government in EU trading scheme | EU allowance system plus domestic CO2tax with exemption of energy tax for EI sectors and government in EU trading scheme |
|---|---|---|---|---|
| | 2010 | 2010 | 2010 | 2010 |
| **Macroeconomic Aggregates** | with SS recycling of tax revenue | | | |
| *Gross Domestic Product* | -0.10% | -0.13% | -0.13% | -0.14% |
| *Employment* | 0.12% | 0.15% | 0.13% | 0.11% |
| *Private Consumption* | -0.07% | 0.23% | 0.23% | 0.20% |
| *Investment* | -0.11% | -0.08% | -0.08% | -0.07% |
| *Final Energy Consumption* | -3.75% | -2.92% | -2.86% | -2.67% |
| *Share Coal** | -0.70% | -1.17% | -1.15% | -1.19% |
| *Share Oil** | -0.53% | 0.10% | 0.11% | 0.14% |
| *Share Gas** | -0.13% | -0.02% | -0.02% | -0.06% |
| *Share Electricity** | 1.36% | 1.09% | 1.05% | 1.12% |
| *Exports to RW* | -0.56% | -1.28% | -1.30% | -1.27% |
| *Imports from RW* | -0.47% | 0.17% | 0.18% | 0.16% |
| *Real Wage Rate* | 0.29% | -0.02% | -0.07% | -0.13% |
| *Relative Consumer Price* | 0.22% | 0.58% | 0.61% | 0.64% |
| *Terms of Trade* | 0.61% | 2.13% | 2.16% | 2.13% |
| *Current Account (% of GDP)** | 0.02% | -0.14% | -0.15% | -0.15% |
| | | | | |
| **Total Atmospheric Emissions** | | | | |
| *CO2 Emissions* | -12.54% | -12.59% | -12.59% | -12.59% |
| *NOX Emissions* | -12.66% | -11.69% | -11.81% | -11.70% |
| *SO2 Emissions* | -16.75% | -19.60% | -20.03% | -20.07% |
| *VOC Emissions* | -7.82% | -8.41% | -8.57% | -8.51% |
| *PM Emissions* | -17.28% | -20.17% | -20.96% | -21.05% |
| **Environmental Policy** | | | | |
| *Energy Tax (% of GDP)** | -0.07% | -0.05% | -0.08% | -0.12% |
| *Environmental Tax (% of GDP)** | 0.48% | 0.25% | 0.26% | 0.27% |
| *Reduction of Social Security Rate** | 0.72% | 1.24% | 1.21% | 1.13% |
| *CO2 marginal abatement cost (Euro95/tn CO2)* | 19.12 | 13.56 | 14.32 | 14.60 |
| *CO2 marginal abatement cost EU (Euro95/tn CO2)* | 12.76 | 13.56 | 14.32 | 14.60 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **Welfare** | | | | |
| *Economic Welfare* | -0.13% | 0.24% | 0.24% | 0.23% |
| *Total Welfare* | 0.13% | 0.51% | 0.52% | 0.51% |
| *Local Benefits (% of GDP)** | 0.20% | 0.20% | 0.21% | 0.20% |

At sectoral level, as already explained before, the energy intensive sectors participating in the EU trading scheme are the losers as the allowance price is increased from 12.8€/tn to 13.6€/tn. Exemption of the energy tax, totally or of its CO2 component, does not allow to compensate for this, though it has a positive effect.

**Table 21: Sectoral impact at EU level with the minimum energy tax as energy policy associated with the climate policy in 2010**
**(% difference compared to reference)**

| | EU allowance system from 2005, plus domestic CO2tax in 2010 | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto with possibility for government to be an actor on the EU trading scheme | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto with exemption of CO2 component in energy tax for EI sectors in 2010 and possibility for government to be an actor on the EU trading scheme | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto with exemption of energy tax for EI in 2010 and possibility for government to be an actor on the EU trading scheme |
|---|---|---|---|---|
| | | | | |
| **Sectoral Aggregates** | | | | |
| **Domestic Production in Volume** | | | | |
| *Agriculture* | -0.23% | -0.12% | -0.13% | -0.15% |
| *Energy Production* | -4.65% | -3.85% | -3.80% | -3.63% |
| *Ferrous and non ferrous metals* | -0.79% | -1.20% | -1.07% | -0.87% |
| *Chemical Products* | -0.55% | -0.70% | -0.73% | -0.75% |
| *Other energy intensive* | -0.49% | -0.71% | -0.59% | -0.35% |
| *Electric Goods* | -0.15% | -0.49% | -0.49% | -0.49% |
| *Transport equipment* | -0.23% | -0.46% | -0.46% | -0.46% |
| *Other Equipment Goods* | -0.15% | -0.52% | -0.52% | -0.51% |
| *Consumer Goods Industries* | -0.21% | -0.23% | -0.25% | -0.26% |
| *Construction* | -0.11% | -0.07% | -0.06% | -0.05% |
| *Telecommunication Services* | 0.04% | 0.06% | 0.04% | 0.03% |
| *Transport* | -0.92% | -0.70% | -0.74% | -0.76% |
| *Services of credit and insurances* | 0.02% | 0.01% | 0.00% | -0.01% |
| *Other Market Services* | -0.03% | 0.03% | 0.02% | 0.01% |
| *Non Market Services* | 0.00% | 0.07% | 0.06% | 0.06% |
| **Exports in Volume** | | | | |
| *Agriculture* | -0.52% | -0.59% | -0.64% | -0.67% |
| *Energy Exports* | -4.53% | -3.75% | -3.71% | -3.67% |
| *Ferrous and non ferrous metals* | -1.42% | -2.22% | -1.95% | -1.58% |
| *Chemical Products* | -0.81% | -1.14% | -1.19% | -1.22% |

| | | | | |
|---|---|---|---|---|
| *Other energy intensive* | -0.77% | -1.33% | -1.13% | -0.72% |
| *Electric Goods* | -0.10% | -0.73% | -0.74% | -0.75% |
| *Transport equipment* | -0.28% | -0.77% | -0.78% | -0.78% |
| *Other Equipment Goods* | -0.11% | -0.75% | -0.75% | -0.75% |
| *Consumer Goods Industries* | -0.48% | -0.93% | -0.98% | -1.01% |
| *Construction* | -0.07% | -2.61% | -2.75% | -2.77% |
| *Telecommunication Services* | 0.17% | -0.45% | -0.51% | -0.56% |
| *Transport* | -2.03% | -1.82% | -1.92% | -1.97% |
| *Services of credit and insurances* | 0.29% | -0.39% | -0.44% | -0.47% |
| *Other Market Services* | 0.02% | -0.46% | -0.49% | -0.50% |
| *Non Market Services* | 0.06% | -0.46% | -0.51% | -0.55% |
| **Price of Exports** | | | | |
| *Agriculture* | 0.49% | 0.68% | 0.73% | 0.75% |
| *Ferrous and non ferrous metals* | 0.92% | 1.51% | 1.30% | 1.03% |
| *Chemical Products* | 0.42% | 0.65% | 0.68% | 0.70% |
| *Other energy intensive* | 0.54% | 1.08% | 0.91% | 0.56% |
| *Electric Goods* | -0.02% | 0.39% | 0.40% | 0.41% |
| *Transport equipment* | 0.12% | 0.53% | 0.53% | 0.53% |
| *Other Equipment Goods* | -0.01% | 0.40% | 0.40% | 0.40% |
| *Consumer Goods Industries* | 0.25% | 0.60% | 0.63% | 0.64% |
| *Construction* | 0.04% | 1.94% | 2.04% | 2.07% |
| *Telecommunication Services* | -0.16% | 0.41% | 0.46% | 0.51% |
| *Transport* | 1.37% | 1.17% | 1.25% | 1.30% |
| *Services of credit and insurances* | -0.28% | 0.30% | 0.35% | 0.37% |
| *Other Market Services* | -0.17% | 0.30% | 0.33% | 0.36% |
| *Non Market Services* | -0.10% | 0.80% | 0.90% | 0.96% |

### *(2) with the 10 Euro/ton CO2 equivalent energy tax*

Imposing the 10 EURO/ton CO2 equivalent energy tax reduces the EU allowance price and reduces the trade in allowances as more reduction in energy consumption are induced by the energy tax. Both the EU allowance price and the domestic CO2 tax are slightly reduced. The higher energy tax allows a higher reduction in the social security rates and therefore a greater reduction in the labour market distortion and this has a positive effect on private consumption and welfare compared to the previous case. The overall impact remains rather close. It must be noted however that the emission reduction is slightly higher than in the previous scenario because of the reduction in the new Member States induced by the energy tax in the sectors not participating in the EU trading scheme while their Kyoto target as defined in this study did not imply any reduction.

**Table 22: Macroeconomic impact at EU level (22 countries) with the €10 per ton CO2 equivalent energy tax associated with the climate policy in 2010**
**(% difference compared to reference, except for * where difference)**

| | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto | EU allowance system in 2010 plus energy tax of 10Euro /ton CO2 equiv plus domestic tax to reach Kyoto in 2010 | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto, energy tax of 10€ with exemption of CO2 component for EI sectors in 2010 | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto, energy tax of 10€ with exemption for EI sectors in 2010 |
|---|---|---|---|---|
| | 2010 | 2010 | 2010 | 2010 |

| **Macroeconomic Aggregates** | with SS recycling of tax revenue | | | |
|---|---|---|---|---|
| *Gross Domestic Product* | -0.10% | -0.08% | -0.09% | -0.09% |
| *Employment* | 0.12% | 0.38% | 0.32% | 0.30% |
| *Private Consumption* | -0.07% | 0.01% | -0.03% | -0.04% |
| *Investment* | -0.11% | -0.11% | -0.11% | -0.11% |
| *Final Energy Consumption* | -3.75% | -4.31% | -4.21% | -4.16% |
| *Share Coal** | -0.70% | -1.42% | -1.17% | -1.08% |
| *Share Oil** | -0.53% | -0.14% | -0.20% | -0.28% |
| *Share Gas** | -0.13% | -0.01% | -0.03% | -0.10% |
| *Share Electricity** | 1.36% | 1.57% | 1.40% | 1.45% |
| *Exports to RW* | -0.56% | -0.63% | -0.57% | -0.57% |
| *Imports from RW* | -0.47% | -0.42% | -0.47% | -0.49% |
| *Real Wage Rate* | 0.29% | 0.45% | 0.34% | 0.32% |
| *Relative Consumer Price* | 0.22% | 0.21% | 0.22% | 0.24% |
| *Terms of Trade* | 0.61% | 0.70% | 0.61% | 0.61% |
| *Current Account (% of GDP)** | 0.02% | 0.02% | 0.02% | 0.03% |
| | | | | |
| **Total Atmospheric Emissions** | | | | |
| *CO2 Emissions* | -12.54% | -13.59% | -13.60% | -13.60% |
| *NOX Emissions* | -12.66% | -12.86% | -13.21% | -13.21% |
| *SO2 Emissions* | -16.75% | -18.40% | -19.26% | -18.84% |
| *VOC Emissions* | -7.82% | -10.90% | -10.78% | -10.81% |
| *PM Emissions* | -17.28% | -18.56% | -20.00% | -19.52% |
| **Environmental Policy** | | | | |
| *Energy Tax (% of GDP)** | -0.07% | 0.06% | 0.02% | 0.01% |
| *Environmental Tax (% of GDP)** | 0.48% | 0.46% | 0.46% | 0.46% |
| *Reduction of Social Security Rate** | 0.72% | 1.63% | 1.44% | 1.38% |
| *CO2 marginal abatement cost (Euro95/tn CO2)* | 19.1 | 17.6 | 18.7 | 18.8 |
| *CO2 marginal abatement cost, EU(Euro95/tn CO2)* | 12.8 | 9.7 | 12.2 | 12.4 |
| *CO2 marginal abatement cost, domestic(Euro95/tn CO2)* | 23.7 | 23.2 | 23.3 | 23.2 |
| | | | | |
| **Welfare** | | | | |
| *Economic Welfare* | -0.13% | -0.09% | -0.12% | -0.12% |
| *Total Welfare* | 0.13% | 0.18% | 0.17% | 0.16% |
| *Local Benefits (% of GDP)** | 0.20% | 0.21% | 0.21% | -0.06% |

At sectoral level imposing the 10€ tax above the climate policy has a negative impact compared to the scenario with the minimum tax except for the service sectors who benefit the most from the increase in the reduction of the social security reduction. Though the allowance price in the EU trading scheme is reduced, it is not sufficient to compensate for the increase in the energy tax for the energy intensive sectors participating in the market. Granting them exemption allows to reduce this negative impact but at the cost of the other sectors because the lower reduction in the social security contribution it implies.

**Table 23: Sectoral impact at EU level with the €10 per ton CO2 equivalent energy tax associated with the climate policy in 2010**
**(% difference compared to reference)**

| | EU allowance system from 2005, plus domestic CO2tax in 2010 to reach Kyoto | EU allowance system in 2010 plus energy tax of 10Euro /ton CO2 | EU allowance system from 2005, plus domestic CO2tax in 2010 to | EU allowance system from 2005, plus domestic CO2tax in 2010 to |
|---|---|---|---|---|

| | | equiv plus domestic tax to reach Kyoto in 2010 | reach Kyoto, energy tax of 10€ with exemption of CO2 component for EI sectors in 2010 | reach Kyoto, energy tax of 10€ with exemption for EI sectors in 2010 |
|---|---|---|---|---|
| | 2010 | 2010 | 2010 | 2010 |
| | with SS recycling of tax revenue | | | |
| **Sectoral Aggregates** | | | | |
| **Domestic Production in Volume** | | | | |
| *Agriculture* | -0.23% | -0.18% | -0.20% | -0.22% |
| *Energy Production* | -0.24% | -0.24% | -0.24% | -0.24% |
| *Ferrous and non ferrous metals* | -0.79% | -1.14% | -0.87% | -0.75% |
| *Chemical Products* | -0.55% | -0.68% | -0.71% | -0.72% |
| *Other energy intensive* | -0.49% | -0.62% | -0.50% | -0.46% |
| *Electric Goods* | -0.15% | -0.17% | -0.15% | -0.15% |
| *Transport equipment* | -0.23% | -0.22% | -0.21% | -0.21% |
| *Other Equipment Goods* | -0.15% | -0.18% | -0.16% | -0.15% |
| *Consumer Goods Industries* | -0.21% | -0.17% | -0.19% | -0.20% |
| *Construction* | -0.11% | -0.12% | -0.12% | -0.12% |
| *Telecommunication Services* | 0.04% | 0.07% | 0.05% | 0.05% |
| *Transport* | -0.92% | -0.90% | -0.92% | -0.92% |
| *Services of credit and insurances* | 0.02% | 0.03% | 0.02% | 0.02% |
| *Other Market Services* | -0.03% | 0.01% | -0.01% | -0.02% |
| *Non Market Services* | 0.00% | 0.02% | 0.01% | 0.01% |
| **Exports in Volume** | | | | |
| *Agriculture* | -0.52% | -0.48% | -0.50% | -0.52% |
| *Energy Exports* | -4.53% | -4.42% | -4.38% | -4.52% |
| *Ferrous and non ferrous metals* | -1.42% | -2.10% | -1.53% | -1.32% |
| *Chemical Products* | -0.81% | -1.04% | -1.08% | -1.11% |
| *Other energy intensive* | -0.77% | -1.00% | -0.78% | -0.69% |
| *Electric Goods* | -0.10% | -0.11% | -0.08% | -0.09% |
| *Transport equipment* | -0.28% | -0.29% | -0.25% | -0.26% |
| *Other Equipment Goods* | -0.11% | -0.14% | -0.10% | -0.10% |
| *Consumer Goods Industries* | -0.48% | -0.45% | -0.48% | -0.50% |
| *Construction* | -0.07% | -0.04% | -0.06% | -0.08% |
| *Telecommunication Services* | 0.17% | 0.26% | 0.22% | 0.19% |
| *Transport* | -2.03% | -2.02% | -2.04% | -2.05% |
| *Services of credit and insurances* | 0.29% | 0.39% | 0.36% | 0.36% |
| *Other Market Services* | 0.02% | 0.06% | 0.06% | 0.05% |
| *Non Market Services* | 0.06% | 0.23% | 0.16% | 0.09% |
| **Price of Exports rel. EU average** | | | | |
| *Agriculture* | 0.49% | 0.47% | 0.48% | 0.50% |
| *Ferrous and non ferrous metals* | 0.92% | 1.42% | 1.00% | 0.84% |
| *Chemical Products* | 0.42% | 0.56% | 0.58% | 0.59% |
| *Other energy intensive* | 0.54% | 0.73% | 0.53% | 0.45% |
| *Electric Goods* | -0.02% | -0.02% | -0.04% | -0.03% |
| *Transport equipment* | 0.12% | 0.15% | 0.12% | 0.12% |
| *Other Equipment Goods* | -0.01% | 0.00% | -0.02% | -0.02% |
| *Consumer Goods Industries* | 0.25% | 0.25% | 0.26% | 0.27% |
| *Construction* | 0.04% | 0.02% | 0.03% | 0.05% |
| *Telecommunication Services* | -0.16% | -0.23% | -0.21% | -0.18% |
| *Transport* | 1.37% | 1.34% | 1.35% | 1.37% |

| | | | | |
|---|---|---|---|---|
| *Services of credit and insurances* | -0.28% | -0.36% | -0.34% | -0.33% |
| *Other Market Services* | -0.17% | -0.23% | -0.21% | -0.20% |
| *Non Market Services* | -0.10% | -0.38% | -0.27% | -0.15% |

### *(3) Comparing the scenarios for the Kyoto period*

To highlight the implications of the policy assumptions, the results for three scenarios are reproduced in Table 24. They clearly show that ensuring cost efficiency through a better exploitation of the cheapest CO2 reduction possibilities and generating income used for reducing the labour cost can contribute to limit the welfare cost of the Kyoto target.

**Table 24: Macroeconomic impact at EU level (22 countries) of energy tax policies associated with the climate policy in 2010**
**(% difference compared to reference, except for * where difference)**

| | EU allowance system plus domestic CO2tax in 2010 to reach Kyoto | EU allowance system plus domestic CO2tax in 2010 to reach Kyoto with possibility for government to be an actor on the EU trading scheme | EU allowance system in 2010 plus MINtax 10Euro /ton CO2 equiv plus domestic tax to reach Kyoto in 2010 |
|---|---|---|---|
| | 2010 | 2010 | 2010 |
| **Macroeconomic Aggregates** | with SS recycling of tax revenue | | |
| *Gross Domestic Product* | -0.10% | -0.13% | -0.08% |
| *Employment* | 0.12% | 0.15% | 0.38% |
| *Private Consumption* | -0.07% | 0.23% | 0.01% |
| *Investment* | -0.11% | -0.08% | -0.11% |
| *Final Energy Consumption* | -3.75% | -2.92% | -4.31% |
| *Share Coal** | -0.70% | -1.17% | -1.42% |
| *Share Oil** | -0.53% | 0.10% | -0.14% |
| *Share Gas** | -0.13% | -0.02% | -0.01% |
| *Share Electricity** | 1.36% | 1.09% | 1.57% |
| *Exports to RW* | -0.56% | -1.28% | -0.63% |
| *Imports from RW* | -0.47% | 0.17% | -0.42% |
| *Real Wage Rate* | 0.29% | -0.02% | 0.45% |
| *Relative Consumer Price* | 0.22% | 0.58% | 0.21% |
| *Real Interest Rate* | 0.00% | 0.00% | 0.00% |
| *Terms of Trade* | 0.61% | 2.13% | 0.70% |
| *Current Account (% of GDP)** | 0.02% | -0.14% | 0.02% |
| | | | |
| **Total Atmospheric Emissions** | | | |
| *CO2 Emissions* | -12.54% | -12.59% | -13.59% |
| *NOX Emissions* | -12.66% | -11.69% | -12.86% |
| *SO2 Emissions* | -16.75% | -19.60% | -18.40% |
| *VOC Emissions* | -7.82% | -8.41% | -10.90% |
| *PM Emissions* | -17.28% | -20.17% | -18.56% |
| **Environmental Policy** | | | |
| *Energy Tax (% of GDP)** | -0.07% | -0.05% | 0.06% |
| *Environmental Tax (% of GDP)** | 0.48% | 0.25% | 0.46% |
| *Reduction of Social Security Rate** | 0.72% | 1.24% | 1.63% |
| *CO2 marginal abatement cost (Euro95/tn CO2)* | 19.12 | 13.56 | 17.60 |
| *CO2 marginal abatement cost, EU (Euro95/tn CO2)* | 12.81 | 13.56 | 9.75 |

| | | | |
|---|---|---|---|
| *CO2 marginal abatement cost, domestic (Euro95/tn CO2)* | 23.71 | 13.56 | 23.20 |
| | | | |
| **Welfare** | | | |
| *Economic Welfare* | -0.13% | 0.24% | -0.09% |
| *Total Welfare* | 0.13% | 0.51% | 0.18% |
| *Local Benefits (% of GDP)** | 0.20% | 0.20% | 0.21% |

## b) The post-2012 period

The climate policy for this scenario assumes a gradually increasing EU wide CO2 tax from 2012 onwards. Two levels of the tax are considered: 25€ and 45€ in 2030. The energy tax applied is the reference energy tax, i.e. the EU minimum tax or the national tax if it is higher in all EU countries. Granting exemptions to the energy intensive sectors reduces slightly the CO2 emission reduction and the reduction in the social security contribution without impact on the total welfare. To reach the same emission reduction, the CO2 tax should be increased shifting the cost of the exemption towards the other sectors and the household as the recycling of the increased energy tax will not compensate entirely the tax increase. In terms of welfare, the cost increases compared to the first commitment period as the reduction in CO2 emissions is higher. This increase can be limited because the policy allows a further reduction in the labour cost. Also the policy implemented is rather cost-efficient as it equalizes the marginal abatement cost in all sectors and countries. On the export market the losses are higher especially for the energy intensive sectors and the transport sector. The more labour intensive sectors are benefiting from the reduction in labour cost.

**Table 25: Macroeconomic impact at EU level (22 countries) of an EU wide CO2 tax of 25€ or 45€ and the reference energy tax in 2030**
**(% difference compared to reference, except for * where difference)**

| | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax, CO2 component exemption for EI sectors | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax full exemption for EI sectors | EU allowance system plus domestic CO2tax in 2010, thereafter 45€ CO2 tax | EU allowance system plus domestic CO2tax in 2010, thereafter 45€ CO2 tax, CO2 component exemption for EI sectors | EU allowance plus domestic CO2tax in 2010, thereafter 45€ CO2 tax, full exemption for EI sectors |
|---|---|---|---|---|---|---|
| | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 |
| **Macroeconomic Aggregates** | with SS recycling of tax revenue | | | | | |
| *Gross Domestic Product* | -0.13% | -0.12% | -0.12% | -0.24% | -0.23% | -0.23% |
| *Employment* | 0.46% | 0.45% | 0.44% | 0.73% | 0.71% | 0.71% |
| *Private Consumption* | 0.05% | 0.04% | 0.02% | 0.05% | 0.04% | 0.03% |
| *Investment* | -0.14% | -0.13% | -0.12% | -0.23% | -0.21% | -0.20% |
| *Final Energy Consumption* | -4.49% | -4.30% | -4.09% | -7.03% | -6.88% | -6.70% |
| *Share Coal** | -1.53% | -1.51% | -1.52% | -2.01% | -2.00% | -2.01% |
| *Share Oil** | -0.34% | -0.28% | -0.30% | -0.75% | -0.69% | -0.72% |
| *Share Gas** | -0.02% | -0.02% | -0.05% | -0.12% | -0.12% | -0.14% |
| *Share Electricity** | 1.91% | 1.83% | 1.88% | 2.88% | 2.82% | 2.88% |
| *Exports to RW* | -0.71% | -0.66% | -0.62% | -1.18% | -1.13% | -1.10% |
| *Imports from RW* | -0.32% | -0.33% | -0.34% | -0.42% | -0.43% | -0.44% |
| *Real Wage Rate* | 0.41% | 0.39% | 0.36% | 0.67% | 0.66% | 0.63% |
| *Relative Consumer Price* | 0.31% | 0.31% | 0.32% | 0.51% | 0.51% | 0.53% |
| *Terms of Trade* | 0.77% | 0.72% | 0.68% | 1.30% | 1.26% | 1.22% |
| *Current Account (% of GDP)** | 0.01% | 0.01% | 0.02% | 0.02% | 0.02% | 0.02% |
| | | | | | | |
| **Total Atmospheric Emissions** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| *CO2 Emissions* | -19.54% | -19.09% | -18.99% | -27.21% | -26.87% | -26.80% |
| *NOX Emissions* | -18.33% | -17.94% | -17.79% | -25.89% | -25.55% | -25.48% |
| *SO2 Emissions* | -29.75% | -29.45% | -29.29% | -39.51% | -39.32% | -39.18% |
| *VOC Emissions* | -13.39% | -13.16% | -13.07% | -19.74% | -19.51% | -19.50% |
| *PM Emissions* | -30.08% | -30.10% | -29.94% | -39.78% | -39.79% | -39.67% |
| **Environmental Policy** | | | | | | |
| *Energy Tax (% of GDP)** | -0.07% | -0.09% | -0.12% | -0.11% | -0.13% | -0.15% |
| *Environmental Tax (% of GDP)** | 0.61% | 0.61% | 0.61% | 0.99% | 0.99% | 0.99% |
| *Reduction of Social Security Rate** | 2.04% | 1.97% | 1.91% | 3.28% | 3.21% | 3.17% |
| *CO2equivalent tax (Euro95/tn CO2)* | 24.84 | 24.84 | 24.84 | 44.68 | 44.69 | 44.69 |
| | | | | | | |
| **Welfare** | | | | | | |
| *Economic Welfare* | -0.07% | -0.07% | -0.08% | -0.14% | -0.14% | -0.15% |
| *Total Welfare* | 0.27% | 0.26% | 0.25% | 0.32% | 0.32% | 0.31% |
| *Local Benefits (% of GDP)** | 0.24% | 0.24% | 0.24% | 0.34% | 0.33% | 0.33% |

## Table 26: Sectoral impact at EU level of an EU wide CO2 tax of 25€ or 45€ and the reference energy tax in 2030

**(% difference compared to reference)**

| | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax, CO2 component exemption for EI sectors | EU allowance system plus domestic CO2tax in 2010, thereafter 25€ CO2 tax full exemption for EI sectors | EU allowance system plus domestic CO2tax in 2010, thereafter 45€ CO2 tax | EU allowance system plus domestic CO2tax in 2010, thereafter 45€ CO2 tax, CO2 component exemption for EI sectors | EU allowance plus domestic CO2tax in 2010, thereafter 45€ CO2 tax, full exemption for EI sectors |
|---|---|---|---|---|---|---|
| **Sectoral Aggregates** | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 |
| **Domestic Production in Volume** | | | | | | |
| *Agriculture* | -0.20% | -0.20% | -0.21% | -0.34% | -0.34% | -0.35% |
| *Energy Production* | -5.72% | -5.50% | -5.31% | -8.81% | -8.62% | -8.46% |
| *Ferrous and non ferrous metals* | -1.34% | -1.13% | -0.93% | -2.14% | -1.94% | -1.77% |
| *Chemical Products* | -0.64% | -0.63% | -0.63% | -1.07% | -1.06% | -1.06% |
| *Other energy intensive* | -0.78% | -0.60% | -0.38% | -1.28% | -1.11% | -0.90% |
| *Electric Goods* | -0.21% | -0.19% | -0.18% | -0.35% | -0.33% | -0.32% |
| *Transport equipment* | -0.30% | -0.28% | -0.27% | -0.50% | -0.48% | -0.47% |
| *Other Equipment Goods* | -0.25% | -0.23% | -0.22% | -0.40% | -0.38% | -0.37% |
| *Consumer Goods Industries* | -0.19% | -0.19% | -0.19% | -0.32% | -0.32% | -0.33% |
| *Construction* | -0.12% | -0.11% | -0.10% | -0.19% | -0.18% | -0.17% |
| *Telecommunication Services* | 0.05% | 0.04% | 0.04% | 0.08% | 0.08% | 0.07% |
| *Transport* | -0.91% | -0.91% | -0.91% | -1.55% | -1.55% | -1.55% |
| *Services of credit and insurances* | 0.02% | 0.01% | 0.02% | 0.02% | 0.02% | 0.02% |
| *Other Market Services* | -0.01% | -0.01% | -0.01% | -0.02% | -0.01% | -0.02% |
| *Non Market Services* | 0.05% | 0.04% | 0.04% | 0.07% | 0.07% | 0.06% |
| **Exports in Volume** | | | | | | |
| *Agriculture* | -0.54% | -0.55% | -0.56% | -0.90% | -0.90% | -0.91% |
| *Energy Exports* | -5.52% | -5.29% | -5.25% | -8.67% | -8.48% | -8.46% |
| *Ferrous and non ferrous metals* | -2.46% | -2.04% | -1.67% | -3.93% | -3.52% | -3.22% |
| *Chemical Products* | -0.94% | -0.93% | -0.93% | -1.57% | -1.56% | -1.57% |
| *Other energy intensive* | -1.30% | -1.00% | -0.61% | -2.14% | -1.85% | -1.49% |
| *Electric Goods* | -0.21% | -0.19% | -0.19% | -0.34% | -0.32% | -0.32% |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Transport equipment* | -0.37% | -0.34% | -0.33% | -0.62% | -0.59% | -0.58% |
| *Other Equipment Goods* | -0.25% | -0.22% | -0.22% | -0.40% | -0.37% | -0.37% |
| *Consumer Goods Industries* | -0.51% | -0.51% | -0.52% | -0.86% | -0.86% | -0.86% |
| *Construction* | -0.29% | -0.28% | -0.26% | -0.55% | -0.54% | -0.52% |
| *Telecommunication Services* | 0.12% | 0.10% | 0.07% | 0.19% | 0.18% | 0.15% |
| *Transport* | -1.84% | -1.84% | -1.85% | -3.12% | -3.12% | -3.13% |
| *Services of credit and insurances* | 0.13% | 0.12% | 0.11% | 0.22% | 0.21% | 0.20% |
| *Other Market Services* | -0.08% | -0.08% | -0.08% | -0.12% | -0.11% | -0.12% |
| *Non Market Services* | 0.18% | 0.16% | 0.14% | 0.24% | 0.21% | 0.20% |
| **Price of Exports** | | | | | | |
| *Agriculture* | 0.53% | 0.53% | 0.54% | 0.86% | 0.87% | 0.87% |
| *Ferrous and non ferrous metals* | 1.61% | 1.31% | 1.07% | 2.60% | 2.30% | 2.10% |
| *Chemical Products* | 0.49% | 0.48% | 0.49% | 0.82% | 0.81% | 0.82% |
| *Other energy intensive* | 0.90% | 0.67% | 0.37% | 1.48% | 1.27% | 0.98% |
| *Electric Goods* | 0.06% | 0.05% | 0.06% | 0.09% | 0.08% | 0.09% |
| *Transport equipment* | 0.18% | 0.16% | 0.15% | 0.30% | 0.28% | 0.27% |
| *Other Equipment Goods* | 0.07% | 0.05% | 0.05% | 0.12% | 0.10% | 0.10% |
| *Consumer Goods Industries* | 0.28% | 0.28% | 0.28% | 0.47% | 0.47% | 0.47% |
| *Construction* | 0.20% | 0.19% | 0.18% | 0.39% | 0.38% | 0.37% |
| *Telecommunication Services* | -0.08% | -0.07% | -0.05% | -0.15% | -0.13% | -0.11% |
| *Transport* | 1.08% | 1.09% | 1.10% | 1.86% | 1.87% | 1.89% |
| *Services of credit and insurances* | -0.13% | -0.12% | -0.11% | -0.21% | -0.20% | -0.19% |
| *Other Market Services* | -0.04% | -0.03% | -0.02% | -0.08% | -0.07% | -0.06% |
| *Non Market Services* | -0.28% | -0.25% | -0.23% | -0.37% | -0.34% | -0.32% |

# 5. CONCLUSION

This study explores with the general equilibrium model GEM-E3 covering 22 EU countries[11] what is the impact of the implementation of the EU minimum energy tax in the New Member States and how EU energy taxation policy can contribute to the EU climate policy. Different scenarios are examined combining the minimum energy tax and its increase to the equivalent of 10€/ton CO2 with climate policies associating the EU trading scheme with domestic climate policies. Two recycling strategies are considered, either through the general public budget or through a reduction of the social security contributions. Though the recycling within the public budget can alleviate the financial constraint and slightly reduce the interest rate, it is less effective than recycling through a reduction in the social security contributions because of the distortion on the labour market. Therefore its evaluation has been limited to a restricted number of scenarios.

The implementation of the minimum energy tax in the new Member States implies an increase in the tax on most fuels as nearly only transport fuels are taxed in these countries. Recycling the revenue through a reduction of the social security contributions allows reducing the cost of this policy compared to the case where the revenues are used to alleviate the financial constraint. The negative demand effect is reduced as both the domestic and export market benefit from the decrease in the labour cost. The measure has a positive impact on employment and on the real wage rate and hence on private consumption. On the contrary, when no recycling of the revenues is assumed, the positive effect of a decrease in the interest rate on private consumption and investment does not allow compensating for the price effect on the domestic and export market, making this policy more costly. CO2 emissions reductions range from 1 to 4%. The impact on the other EU members is nearly zero.

When a higher and more climate friendly energy tax on final energy demand is implemented in the whole EU, equivalent to a tax of 10€ per ton CO2, the overall impact remains rather small as the tax increase is still limited. Though the tax reduces slightly EU exports, the recycling of the tax revenue

[11] Luxemburg, Malta and Cyprus are not included in the model

through a decrease of the SS rate compensates partly this effect and has a positive impact on private consumption through the increase in employment. This level of taxation reduces the CO2 emissions only with 4% while the Kyoto target imposes a 13% reduction given our reference scenario and is thus not sufficient for the Kyoto target. As it is a tax on final energy demand its efficiency regarding CO2 emissions reduction is more limited compared to a CO2 tax on all emissions because it does not trigger any substitution or reduction in the energy transformation sector.

Implementing the EU allowance scheme combined with a domestic carbon tax such as to reach the Kyoto target imposes a higher cost on the EU economy, but this cost can remain limited by imposing an efficient policy for the allowance allocation and for the revenue recycling strategy. Exempting the sectors participating in the allowance scheme from the minimum tax has only a very small positive effect for these sectors as the decrease in the energy tax is partly compensated by an increase in the allowance price and a smaller reduction in the social security contribution. Through this reduction the burden is shifted to the sectors not participating in the trading scheme. Increasing the energy tax to the equivalent of a 10€ per ton CO2 tax allows a further reduction in the social security rate and is therefore beneficial for employment and private consumption, the cost is however higher for the energy intensive sectors. This result clearly depends on the climate policy assumed here which implies the free distribution of the allowances to the participating sectors. More flexibility in the reduction targets for the different economic agents, implemented in this study by allowing the government to participate in the EU allowance trading scheme, can reduce the cost of reaching the Kyoto target by a better exploitation of the cheaper reduction possibilities in the New Member States.

For the post-2012 period, the implementation of a gradually increasing EU wide CO2 tax of respectively 25€ and 45€ per ton CO2 in 2030, was considered. The cost of this policy measure remains rather limited because it is cost efficient and allows a further reduction in the labour cost. Exempting the energy intensive sectors partly or totally is beneficial for them both in terms of production and exports. The impact on the other sectors remains limited as the exemption hardly changes the potential for labour cost reduction.

From the range of scenarios examined in this study one can conclude that

- the welfare cost of an increase in the energy tax can be limited if the income is used to reduce the distortion on the labour market
- giving exemption, partly or totally, of the energy tax to energy intensive sectors when an EU climate policy is implemented alleviates slightly their cost but shifts the burden of the climate policy to the other sectors in the economy
- the energy tax being a tax on final energy demand does not trigger the CO2 reduction possibilities in the energy sectors; flexibility in the policy set-up to exploit all the reduction possibilities is an important element for limiting the cost of climate policies.

# Annex

## *GEM-E3 : A Computable General Equilibrium Model for studying Economy-Energy-Environment Interactions for Europe and World Regions*[12]

## 1. OVERALL DESCRIPTION OF THE MODEL

The GEM-E3 model is an applied general equilibrium model, covering either the World (separated in 21 regions) or the EU countries (22 countries), that provides details on the macroeconomy and its interaction with the energy system and the environment. It is an empirical, large-scale model, written entirely in structural form. The model computes simultaneously the competitive market equilibrium under the Walras law and determines the optimum balance for energy demand/supply and emission/abatement. The results of ***GEM-E3*** include projections of full input-output tables by region, national accounts, employment, and capital flows, balance of payments, public finance and revenues, household consumption, energy use and supply, and atmospheric emissions. The computation of equilibrium is simultaneous for all domestic markets of all regions and foreign trade links. A major aim of GEM-E3 in supporting policy analysis is the consistent evaluation of distributional effects, across countries, economic sectors and agents. The burden sharing aspects of policy, such as for example energy supply and environmental protection constraints are fully analysed, while ensuring that the European/World economy remains at a general equilibrium condition.

The advantages of computable general equilibrium models for policy analysis, compared with traditional macro-economic models, are now widely admitted. The general equilibrium models allow for consistent comparative analysis of policy scenarios since they ensure that in all scenarios the economic system remains in general equilibrium. In addition, the computable general equilibrium models incorporate micro-economic mechanisms and institutional features within a consistent macro-economic framework, and avoid the representation of behaviour in reduced form. This allows analysis of structural change.

The model has the following general features :

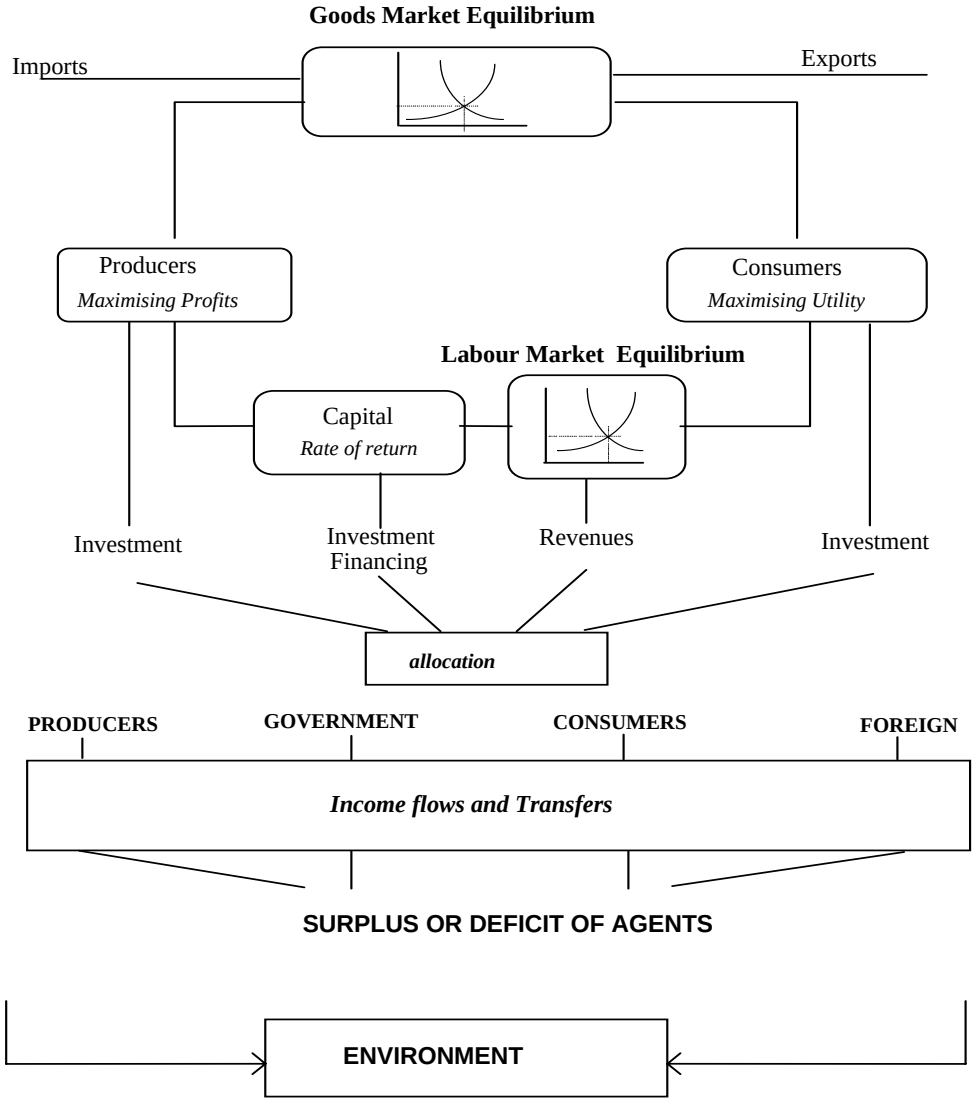
1. It scope is general in two terms: it includes all simultaneously interrelated markets and represents the system at the appropriate level with respect to geography, the sub-system (energy, environment, economy) and the dynamic mechanisms of agent's behaviour.
2. It formulates separately the supply or demand behaviour of the economic agents which are considered to optimise individually their objective while market derived prices guarantee global equilibrium
3. It considers explicitly the market clearing mechanism and the related price formation in the energy, environment and economy markets: prices are computed by the model as a result of supply and demand interactions in the markets and different market clearing mechanisms, in addition to perfect competition, are allowed
4. The model is simultaneously multinational (for the EU or the World) and specific for each country/region; appropriate markets clear European/World wide, while country/region-specific policies and distributional analysis are supported
5. Although global, the model exhibits a sufficient degree of disaggregation concerning sectors, structural features of energy/environment and policy-oriented instruments (e.g. taxation). The

[12] The GEM-E3 model was built under the auspices of European Commission (DG-RES) by a consortium involving principally NTUA, KUL, ZEW, ERASME and BUES

model formulates production technologies in an endogenous manner allowing for price-driven derivation of all intermediate consumptions and the services from capital and labour. For the demand-side the model formulates consumer behaviour and distinguishes between durable (equipment) and consumable goods and services. The model is dynamic driven by accumulation of capital and equipment. Technology progress is explicitly represented in the production functions and for each production factor.

6. The model formulates pollution permits for atmospheric pollutants and flexibility instruments allowing for a variety options, including: allocation (grandfathering, auctioneering, etc.), user-defined bubbles for traders, various systems of exemptions, various systems for revenue recycling, etc.

The figure hereafter gives the basic scheme of the model




# 2. THE CURRENT OPERATIONAL VERSIONS OF THE MODEL

There are two versions of GEM-E3, GEM-E3 EUROPE and GEM-WORLD. They differ in their geographical and sectoral coverage, but the model specification is the same. They use the GAMS software and are written as a mixed non-linear complementarity problem solved by using the PATH algorithm.

## 2.1. The Geographical Aggregation

### *2.1.1. The World version of GEM-E3*

The model uses the GTAP-4 database and the IEA energy statistics. The base year is 1995. The GTAP database includes more than 50 world regions, which have been aggregated into 18 regions. The model code allows however for a user-defined aggregation of regions and definition of the regional coverage of the model. The 18 regions are:

Australia and New Zealand, Japan, China, India, Rapid growing Asian countries, Rest of Asia, USA, Canada, Mexico and Brazil, Rest of Latin America, EU15 countries, New EU member States, Other European countries, Former Soviet Union, Mediteranean countries, Middle East , Africa, Rest of the World.

### *2.1.2. The European version of GEM-E3*

The European version covers 22 EU countries and the ROW (in a reduced form) and is based on the EUROSTAT database (IO tables and National Accounts data) and national databases for the new EU countries. The base year is also 1995.

## 2.2. The sectoral disaggregation level

The model distinguishes 18 productive branches:

| | |
|---|---|
| agriculture | |
| energy | solid fuels, crude oil & refined oil products, gas, |
| electricity | |
| manufactured goods | ferrous and non ferrous ore/metals, chemical products, other energy intensive goods, electric goods, transport equipment, other equipment goods, consumer goods, building and construction (in the World version, consumer goods are further disaggregated into food, textile and other products) |
| services | telecommunications, transport, credit and insurance, other market services, non market services (the World version has only two market services, trade & transport and other market services) |

The data base of the World model includes more than 50 production branches. The model code allows for a user-defined aggregation of branches and traded products.

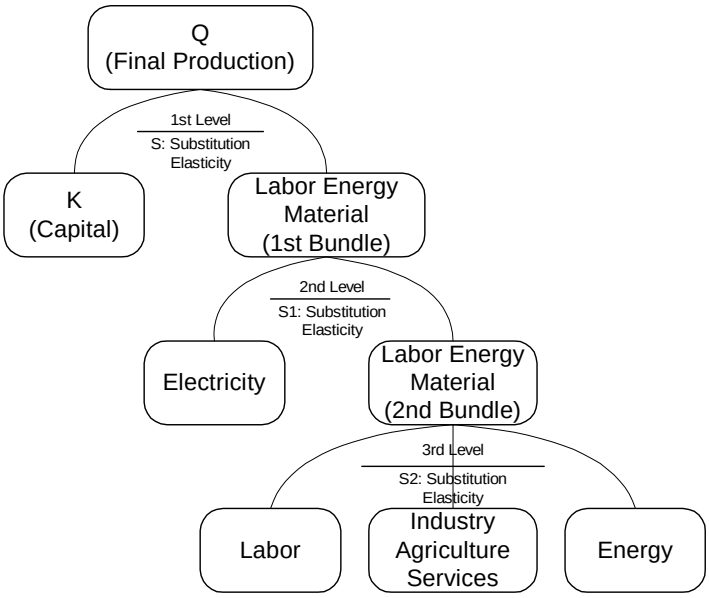
# 3. THE MODEL SPECIFICATION

## 3.1. The domestic producer's behaviour

### *3.1.1. Domestic production*

For each branch, domestic production is represented through a nested separability scheme involving capital, labour, electricity, fuels and materials. Fuels are further divided in coal, gas and oil and materials in fourteen categories of inputs.

**Figure 1: Production Nesting Scheme.**




At the first level production is split into two aggregates, one consisting of capital stock and the other aggregating labour, materials, electricity and fuels. Further down, the aggregate is first split into electricity and the other inputs, then the other inputs into labour, materials and fuels, the ensuing production functions are further divided in their components parts. The CES specification, with factor augmenting technical change, is used throughout. It allows also a coherent representation of the branch reaction (e.g. production factor switching or emission abatement) towards the use of environmental instruments, such as tradable permits, environmental taxation or standards. The model uses dual unit cost functions to represent the supply behaviour of the producers and derives factor demand by means of the Shephards' lemma. The producers supply their goods on the domestic and the export market at the same price.

### *3.1.2. Investment demand*

The desired demand for capital, which fixes the investment demand of the firms, is determined through their optimal decision on factor inputs. The assumptions regarding the expectations of producers on future prices, interest rate and growth of the economy are important for the dynamic characteristics of the model. As the stock of capital is fixed within the year in GEM-E3, the investment decision of the firms affects their production frontier only the next year.

## 3.2. The consumer's behaviour

### *3.2.1. Consumption*

The household behaviour is represented by an intertemporal model of the household sector. In a first stage the household decides each year on the allocation of its resources between present and future consumption of goods and leisure. This decision is modelled as the maximisation of an intertemporal utility function under a life-time resource constraint, using a Linear Expenditure System formulation. It derives the saving and consumption by households and their labour supply.

In a second step, the household allocates its consumption between durable goods and non-durables, again through a LES scheme. The categories of goods considered in the model are given in Table 27.

**Table 27: Consumption Categories.**

| | |
|---|---|
| Non durables | Food, beverages & tobacco, fuel and power, housing, house furniture, purchased transport, operation of transport, clothing, medical and health expenditure, communication, recreation, entertainement, other services |
| Durables | Cars, heating systems, electric appliances |

Special care is given to the treatment of durable goods by explicitly linking the consumption of specific non durables to the stock of durable. The price of the durable used in the consumption decision thus reflects not only the market price of the durable but also the price of the non durables linked to the durable. It can also incorporate the cost for the consumer of environmental policies.

## 3.3. The government

Government final demand by product is obtained by applying fixed coefficients to the exogenous volume of government consumption and investment.

The model distinguishes 9 categories of receipts: indirect taxes (mainly excises), value added taxes, production subsidies, environmental taxes, social security contributions and transfers, import duties, foreign transfers and revenue from government firms.

## 3.4. The rest of the world

As the European model does not cover the whole planet, the behaviour of the rest of the world is exogenous : imports demanded by the ROW depend on the price offered by the exporters from the European Union and exports from the ROW to the European Union, i.e. the supply of the ROW, occur at a fix price. For the World model, all behaviour are endogenous.

## 3.5. Aggregate domestic demand

The specification of the model assumes further that the total domestic demand by branch (from household, producers and government) can be satisfied either by domestically produced goods either by imported goods, though they are not considered perfect substitutes. This allocation occurs through the minimisation of the buyer's total cost, following the Armington type formulation. The price used in the demand function is the 'composite' good price, a function of the supply price of the domestically produced goods and the price of the imported goods.

The total imports by branch are, at a second level, allocated over the countries of origin according to the relative import prices. The EU countries/World regions buy imports at the prices set by the supplying countries following their export supply behaviour.

The model computes, for each branch and for each EU country/World region, the imports from and the exports to each EU country/World region and to the ROW in the form of a trade matrix.

## 3.6. Equilibrium on the good and labour markets

In the goods market a distinction is made between tradable and non tradable goods. For the tradable goods the equilibrium condition refers to the equality between the supply of the composite good, related to the Armington equation, and the domestic demand for the composite good. The equilibrium condition assumes at this stage perfect competition on the good markets.

For the non tradable, there is no Armington assumption and so the good is homogenous. The equilibrium condition serves then to determine domestic production, the supply behaviour being modelled through the supply price equation.

For the labour market, at this stage it is assumed that wage are flexible such as to ensure full employment. On the demand side we have the labour demand by firms (derived from their production behaviour) and on the supply side we have the total available time resources of the households minus their desire for leisure (derived from the maximisation of their utility function). The equilibrium condition serves to compute the wage rate. Another version of GEM-E3 allows wage-rigidity and hence the possibility of unemployment.

## 3.7. The income account

The income flows in the real sector of the model are grouped within the framework of a Social Accounting Matrix, which ensures consistency and equilibrium of flows from production to the agents and back to consumption.

Equilibrium, in quantity and in value, on the good and labour market is guaranteed by the price formation mechanism on these markets.

## 3.8. Environmental externalities

The model evaluates the energy-related emissions of GHG (CO2, CH4, N2O, PFC, HFC, SF6), NOx, SO2, VOC and PM as a function of the energy consumption or sectoral production and the abatement level per branch and per pollutant. These emissions are then translated into concentration/deposition of pollutants, taking into account the transportation (between countries) and transformation mechanism of pollutants. In a final step, the damage generated by these concentration/deposition of pollutants are computed in physical units and valued through valuation function,

Three types of instruments are formulated: taxes, tradable pollution permits, and emission standards (upper bounds on sectors and/or countries). A variety of policy institutional regimes associated to these instruments are considered (burden sharing rules, limits on trade, recycling mechanism). The possibility for market power in permit markets is also modelled.

## 3.9. Substitution and price elasticities in GEM-E3

**Table 28: Production Function substitution elasticities**

| | |
|---|---|
| 1st level | - between capital and other production factors: 0.4 for goods sectors and 0.3 for service sectors and agriculture |
| 2nd level | - between electricity and the other inputs (labour, fuel and other materials): 0.2 for all sectors except energy intensive sectors where 0.4 |
| 3rd level | - between labour, fuel and other materials: 0.3 for all sectors |
| 4th level | - between the different fuels: 0.9 for energy intensive sectors and electricity, 0.1 for fuels and 0.6 for other except transport where 0.4<br>- between the different materials: 0.5 for energy intensive sectors, 0.1 for fuel sectors (coal, gas and oil) and transport, 0.3 for other sectors |

**Table 29: Armington import elasticities**

| | |
|---|---|
| 1st level | - between imports and domestic production: 0.6 for energy sectors, 1.5 for industrial sectors, 0.6 for service sectors, 1.2 for agriculture and transport |
| 2nd level | - between the imports from the different countries: 0.8 for energy sectors, 2.4 for industrial sectors and transport, 1.6 for service sectors and agriculture |

**Labour supply elasticities: 0.2**

The elasticities were derived from literature review and are mostly based on econometric estimation described in the literature.

## 3.10. Policy Evaluation

Equity and cost-efficiency are two criteria brought forward for the evaluation of climate policies. The impact on local pollution, i.e. the ancillary benefits, is another element getting more and more importance in the evaluation process. The policy evaluation, as implemented in GEM-E3 is through the monetization of the damage from the different air pollutant and the integration of the different elements in an overall welfare evaluation.

As such, the trade-off between different pollutant reduction or between pollution damage and pollution abatement is modelled through the damage they potentially generate and the trade-off between cost-efficiency and equity is taken care through the inequality aversion parameter. Varying the inequality aversion parameter allows to rank different options regarding equity without explicit knowledge of decision makers preferences.

It is based on the standard approach in welfare economics by defining a Social Welfare Function[13].

$$W = \sum_{i=1}^{R} \frac{W_i^{(1-\varepsilon)}}{(1-\varepsilon)}$$

where $W_i$ represent the Region i welfare derived from the consumer's utility function, which includes in a separable way the utility from the consumption of goods and leisure and the environmental utility

$\varepsilon$ represent the degree of inequality aversion

If $\varepsilon=0$, the marginal utility is equal for all regions, an equal weight is given to the welfare of the different regions; only efficiency matters.

When the value of $\varepsilon$ increases, the degree of inequality increases and the equity aspect becomes more important in the evaluation of policies.

If $\varepsilon=1$, utility is measured on a logarithmic scale, the marginal utility equals the inverse of the regional welfare

The Social Welfare Function incorporates three effects: effects on the total value of private goods, the effect on the environmental and the equity effects (which depend on the degree of income inequality aversion).

[13] Such a function can incorporate two limiting cases: the utilitarian approach (social welfare is the sum of the individual utilities) and the Rawlsian approach (social welfare = welfare of the worst-off individuals)