ASSESSMENT AND IMPROVEMENT OF METHODOLOGIES USED FOR GREENHOUSE GAS PROJECTIONS

Preliminary guidelines to develop CO2 - GHG projections for the industry sector

Introduction

This document relates to energy related GHG emissions reported in CRF table Table1s1 – Manufacturing industries and construction - and CO2 process emissions reported in Table2(I)s1.
The analysis of data reported by EU member states demonstrates that MS use different definitions for energy and process emissions. For example Germany report 80 % of GHG emissions from steel production as process emissions whereas Belgium reports only 15 % as process emissions. Germany also reports all emissions from the chemical industry as process emissions.

European trends

Other non specified activities is the major source of CO_2 emissions in the CRF classification, followed by Iron & steel industries, Chemical industries, and Cement production in EU-27 (Figure 1).

Total industrial CO_2 emissions decreased by 0.6 % yearly between 1995 and 2005 in EU25. This figure reflects changes in production volumes, fuel switches and energy efficiency increases, as well as increases in CHP use.

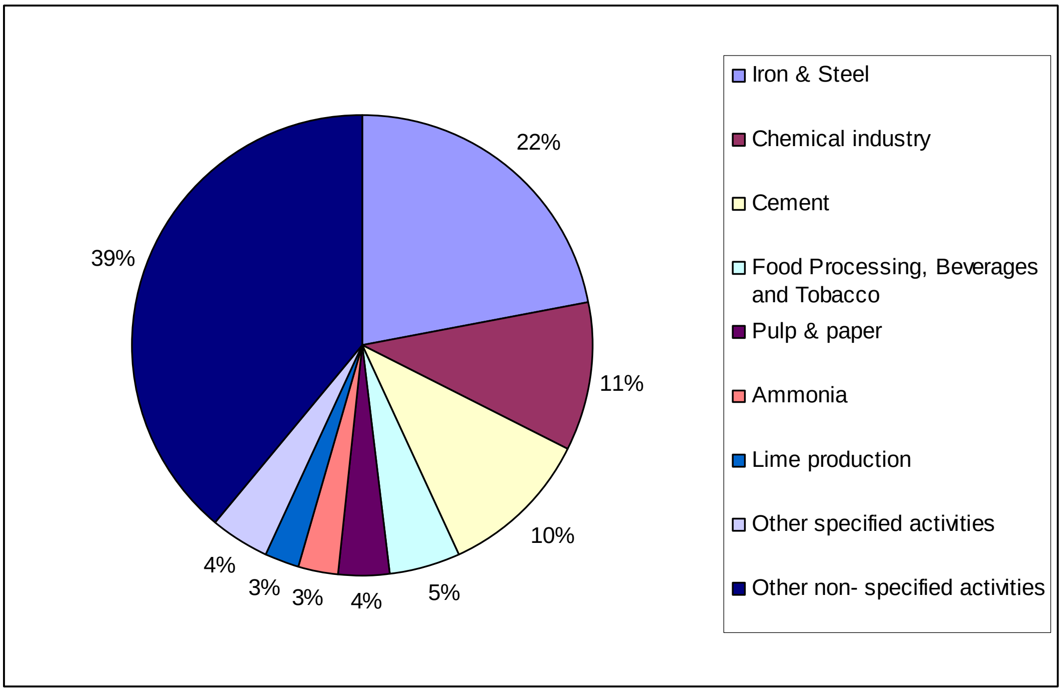

Figure 1: CO_2 emissions from industrial sources in EU-27 in 2005

Iron & Steel

CRF Table 1s1 2. Manufacturing industries a. iron and steel and Table 2(I)s1 C. Metal production 1. iron and steel production

CO2 emissions from Iron & Steel fell by 1,3% yearly between 1995 and 2005, whereas steel production increased by 0.8 %. This opposite trends are mainly explained by a partial shift from oxygen (or blast furnace) steel to electro steel, the latter one starting from scrap. Shifting from oxygen steel to electro steel reduces CO2 emissions approximately by 85 %.[1]

The production of pig iron from iron ore, using coke and other carbon as reducing agent, is the most CO_2 intensive process in the steel production. Differences between MS reflect differences in steel quality (flat steel - construction steel, remaining C content) differences in processes and differences in iron ore qualities. However, we can conclude that Poland and Hungary have improved the process dramatically compared by the 1990 situation. The observed differences can relatively be explained by the arguments mentioned above.

[1] Own calculation

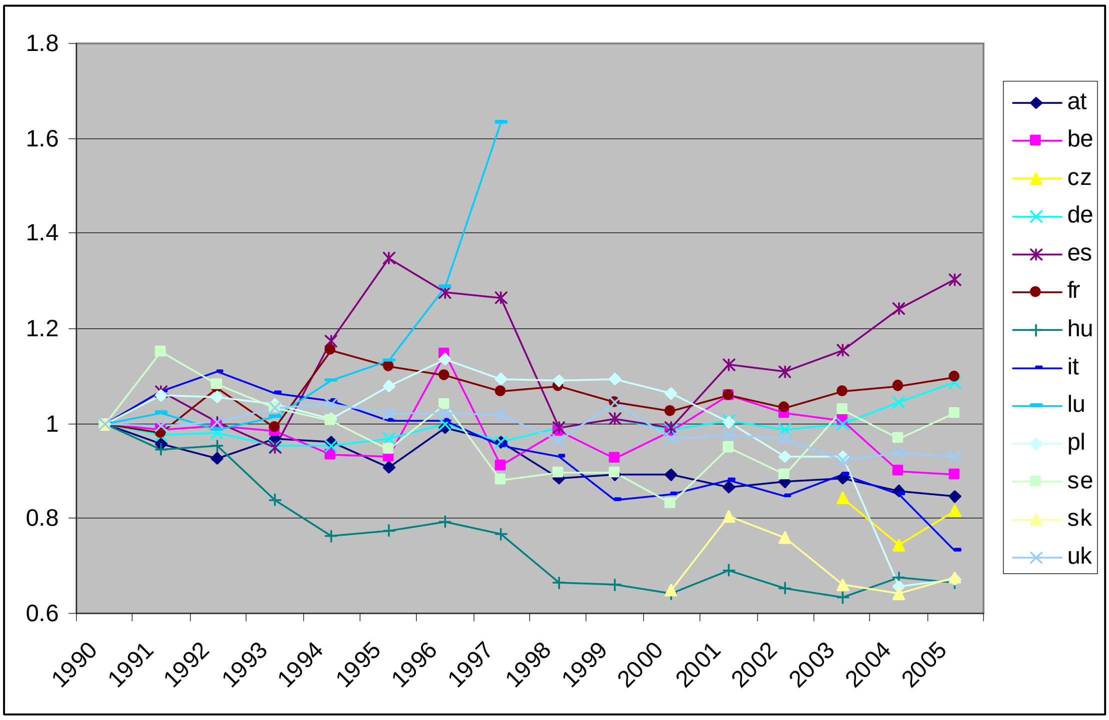

Figure 2: CO2 emissions of steel production expressed as a fraction of pig iron production.

Activities projection

At EU-15 level we have not found a stable statistical relationship between GDP and steel production and value added of the steel sector is less then 0.5 % of GDP. According to this analysis the GDP can not be used as an indicator for steel production.

Steel activity is driven by international steel markets. After 10 years of relative stable activities, the Europeans steel market is booming by a sharp increase in demand from China. Steel prices have doubled. Profitability of steel production is at a very high level. Actually European steel production is *limited by production capacities* but European steel producers are taking actions to increase production, even by reactivating *mothballed installations*[2].

This situation is not in favor of reducing GHG emissions from steel production. GHG efficiency of steel production might even decrease as mothballed installations might not be as efficient as newer plants.

Chemical industries

CRF table 1s1 and Table 2(I)s1 B row B Chemical industry 5. other

[2] Acerlor Mittal recently reactivated one blast furnace in Belgium

Chemical industries includes various organic and an-organic processes. One of the staring points of organic chemistry is steam cracking of naphtha to produce ethylene, propylene and butadiene (EPB). This basic process is biggest source of GHG emissions in chemical industry[3]. The production of EPB has increased by 25 % from 1995 onwards and even by 47 % from 1992 onwards[4].

Cracking capacities are mainly concentrated in 7 member states (Belgium, Germany, Netherlands, France, Italy, UK and Spain). However, looking at reported CO_2 emissions suggest some serious mistakes in the CRF reporting for Germany and UK. Together they account for 33% of the cracker capacities. **(reaction on this by Germany and UK would be appreciated)**

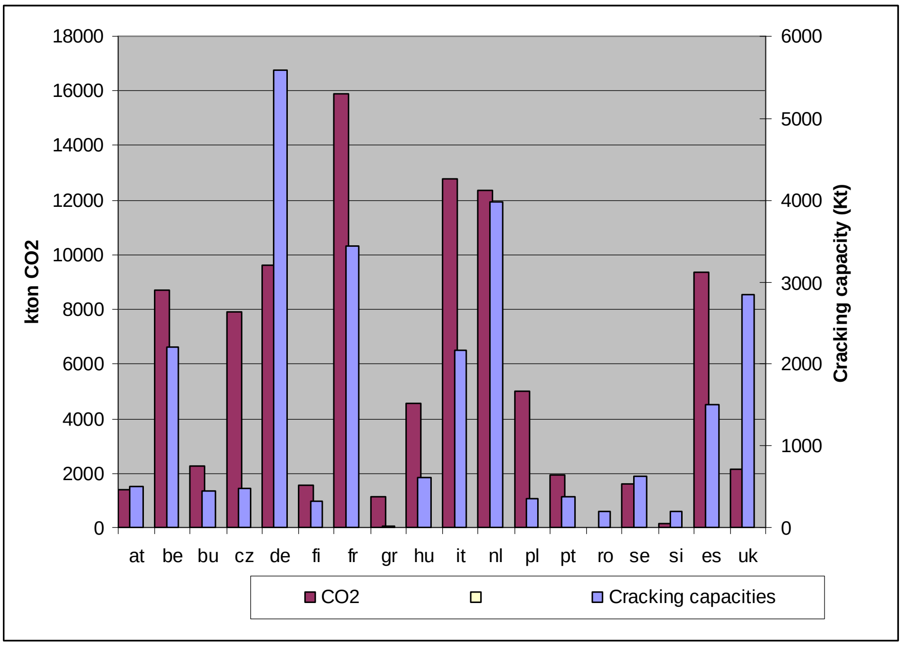

Figure 3: European cracking capcities (2005) and CO2 emissions in CRF tables.

By this we can not drawn any hard conclusions regarding GHG efficiency improvements in EU level, nor can we draw any unbiased conclusion regarding CO2 emissions and value added.

Reported EU-27 CO2 emissions have increased by 1.9 % between 2000 and 2005 which correlates to the increase in value added in the same period. Between 1995 and 2002 per unit of value added CO2 emissions have decreased by 30 %, but from 2002 onwards this trend has not been observed any longer. The change in trend might reflects different facts:

- changes in production patterns, stronger growth of fine chemicals

[3] European CO2 emissions from ethylene production are estimated at 37.4 Mton , based on CEFIC production figure of 21600 kton and a IPCC tier1 emission factor of 1,73 ton CO2 / ton ethylene, which equals 38 % of the CO2 emissions of the chemical sector (excluding ammonia production).
[4] CEFIC

- increased use of CHP
- improving energy efficiency by reducing heat losses, improved catalysts …

(EU-15 and EU-27 left scale, NMS right scale)

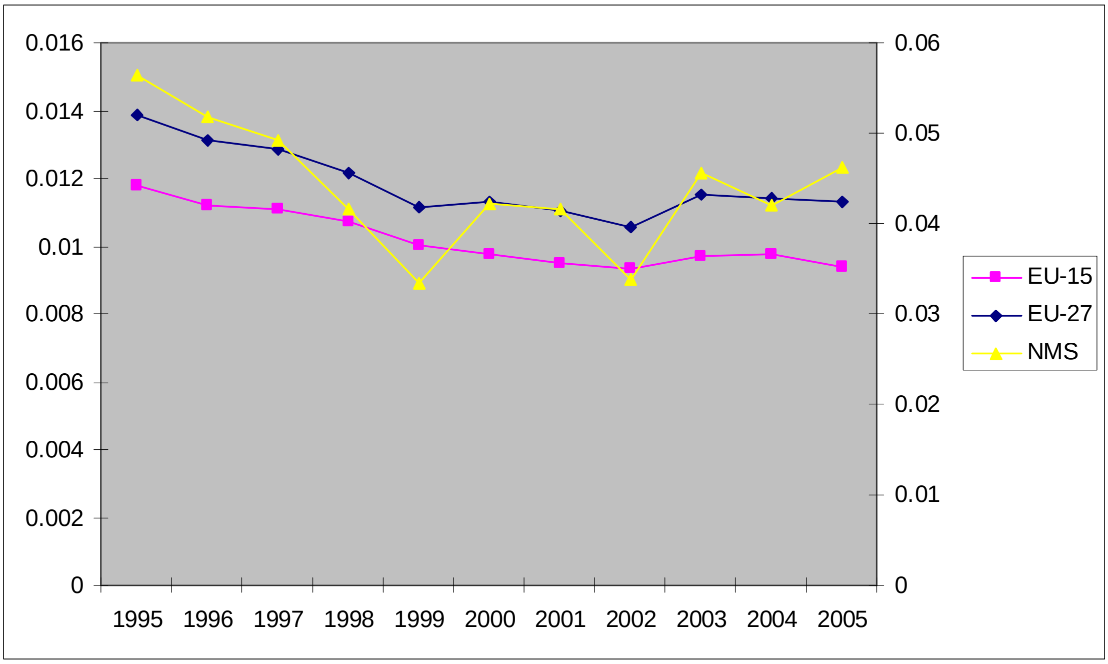

Figure 4: CO2 emissions per unit of value added in chemical industries in EU-27

Activity projection

For GHG projection purposes we recommend to separate crackers and other chemical installations.

In CRF tables relevant indicators (ethylene production, methanol production) have been defined but only a few MS have reported these figures and this is not sufficient to give a representative picture.

The production EPB in Europe has followed a stable growth path between 1992 and 2007. Between 2000 and 2007 the production increased by 2.5% yearly.
Whether this trend will continuo is difficult to say. World demand for ethylene and derived products is likely to continue to grow but it is difficult to say how this will affect European production capacities. A further expansions would be logical in a WOM scenario but the European emissions trading system might have an effect on investment decisions for additional capacities in EU but a slow-down of the production is very unlikely.

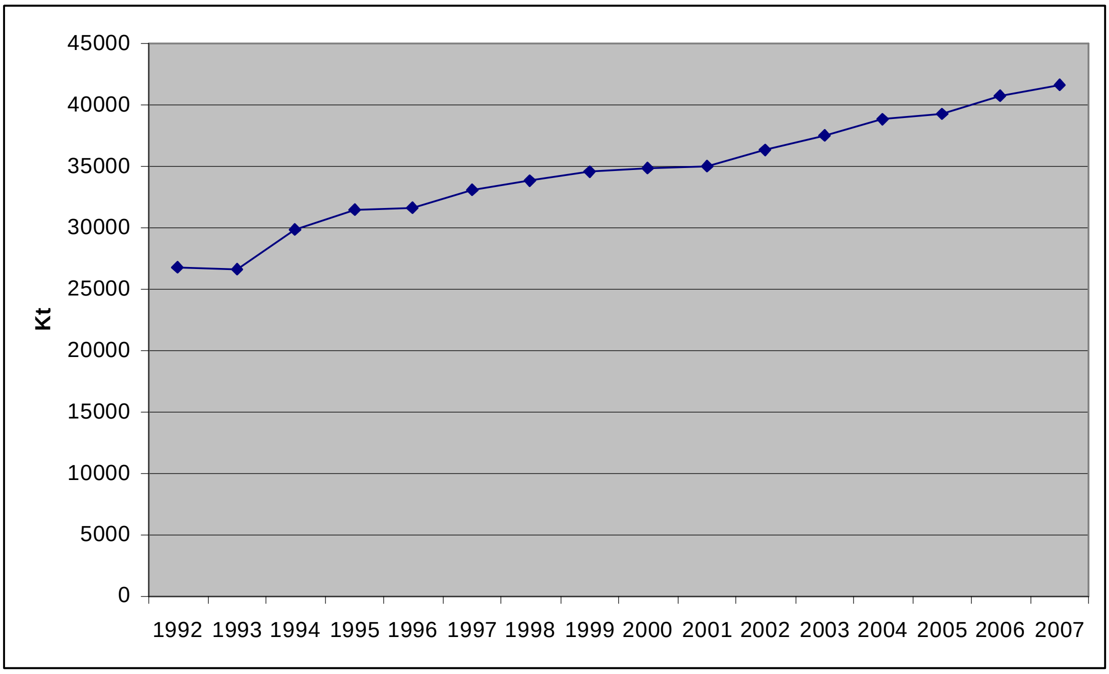

Figure 5: Production of Ethylene, Propylene and Butadiene in West Europe

(source: CEFIC)

For other chemical industries we don't have any useful output indicator. In EU-25 chemical industries had an average growth rate of 1, 7 % whereas GDP grew by 2.1 % [5].

Cement production (clinker production)

Table 2(I)s1 B row A Mineral products 1. Cement industry

The production of clinker is the most energy intensive process in cement production. Alternatively blast furnaces slacks are used in cement production. Cement produce from blast furnace slacks is far less energy intensive.

In CRF tables, only process emissions from clinker production are considered. According to the BREF[6] approximately 62 % of the CO2 emissions originate from the calcining process and whereas 38 % relate to energy consumption. Germany report GHG emissions related to energy consumption in cement production, but most other member states have included this in Table1s1 f. Other. Separate reporting would allow to analyze changing trends among member states. *For GHG projections it would also be logic to use the same activity variables for process emissions and energy consumption.*

[5] CEFIC Facts and figures 2007 (www.cefic.org)
[6] IPPC, Reference document on Best Available Techniques in the Cement and Lime industries.

Activities projection

Cement is mainly produced for local consumption and is exceptionally transported over long distances. However, a map of EU-27 looks like patchwork and exports and imports of cement are still considerable compared to local production. For smaller member states net trade (export – imports) can take up to 50 % of local production.

Imports and export of cement are not the only reason for changing trends and fluctuations in the clinker production/value added relationship ratio. Changes in the clinker content in cement and changes in production methods and choice of building materials are important too. However, for EU-15 and EU-27 we can observe a relative stable relationship between clinker production and value added of the production sector.

MS facing high economic growth figures might expect strong growth figures for the construction sector as well. Growth figures for the construction sector might exceed GDP expectations in those countries.

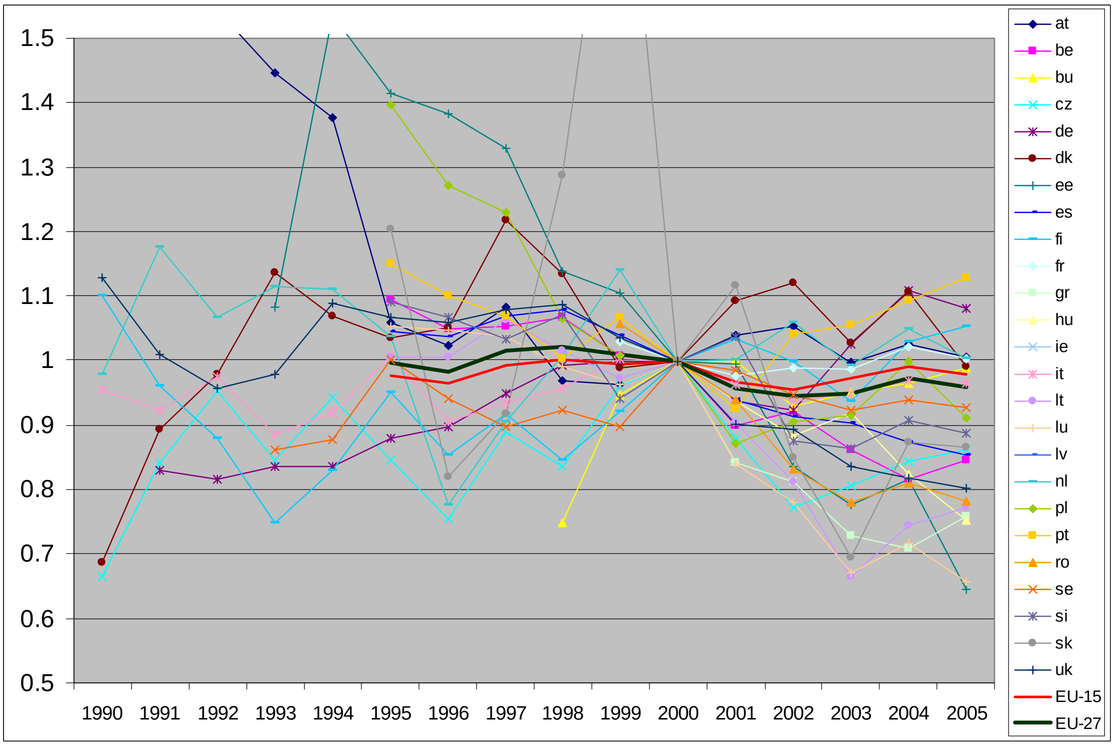

Figure 6: Clinker production related to value added in construction sector

Other non-specified activities

This sector covers 39 % of the industrial CO_2 emissions in EU. Approximately 5 % of this relates to energy consumption in cement production. The remaining 34 % covers other activities, not elsewhere mentioned in the CRF tables (see annex).

CO_2 emissions for this category have decreased by 1% per year between 1995 and 2005. For EU-15 these emissions have stabilized from 1995 onwards, whereas for the new member states they have decreased by 4.6 % yearly between.

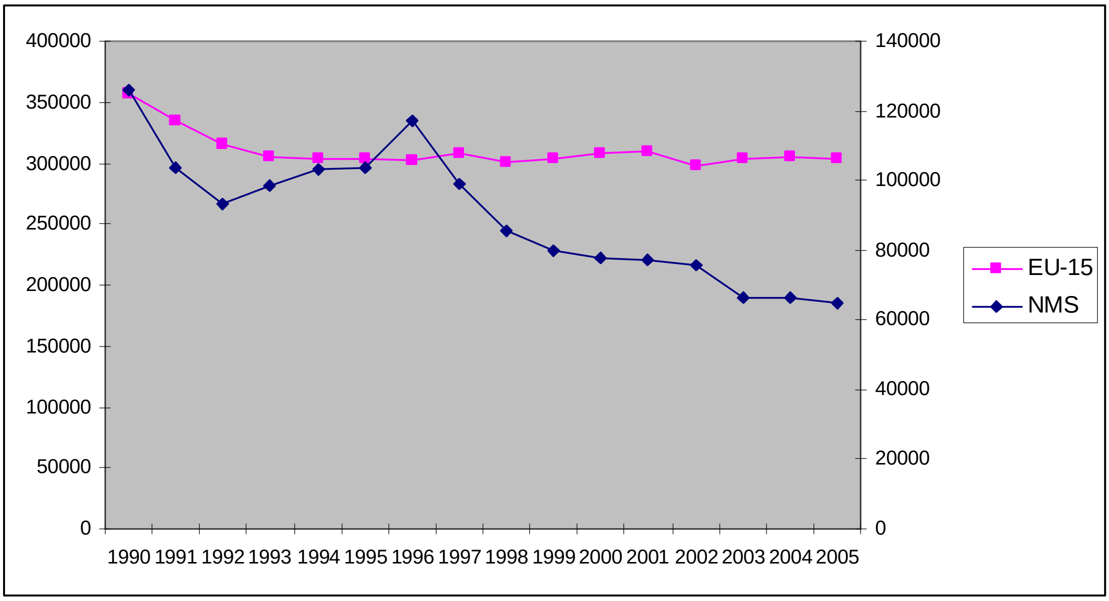

Figure 7: Trends in GHG emissions for other industries.

In EU-15 energy consumption increased by 0.5 % yearly between 1995 and 2005. The stabilization of GHG emissions in this period is the result from fuel switching.
The share of gas in energy consumption increased from 46 % in 1995 to 53 % in 2005 and biomass increased from 3.9 % to 5.9 % in the same period. Solid fuels decreased from 16 % to 10 %.

Value added has increased by 1.87 % yearly. The relationship between energy consumption and value added in presented in Figure 8. This graphs can be interpreted in different ways. Either we can say that there is a one to one relationship (unit elasticity) and an energy efficiency improvement, either we can say that we only observe an elasticity of 0.27. An analysis at MS level might provide more insight into this.

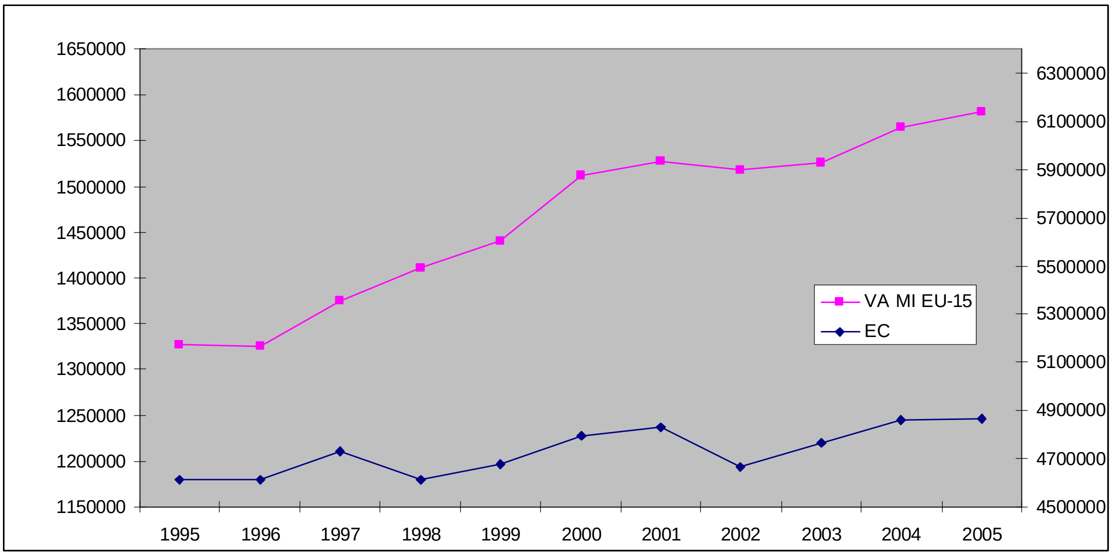

Figure 8: Energy consumption of other industries and value added in EU-15

For the new member we have a complete different situation Value added has increased by 8.9 % yearly whereas energy consumption has decreased by 4% yearly.

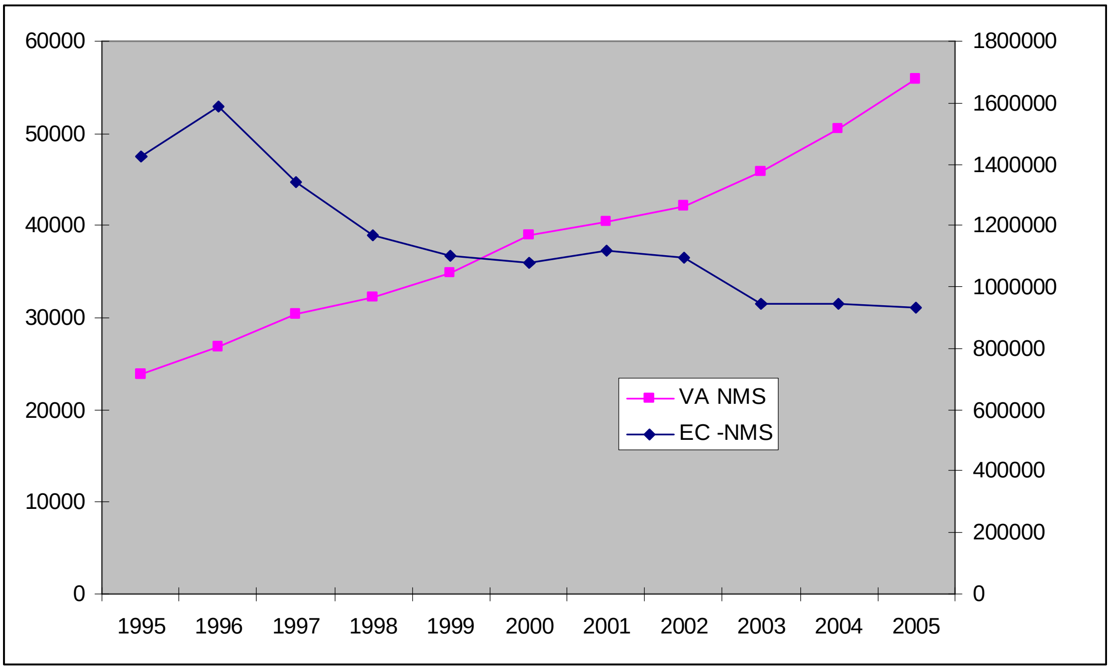

Figure 9: Energy consumption of other industries and value added for the new member states

Tier 1: Simple approach based on activity data

The development of GHG emission scenario requires an activity scenario expressed in physical terms or in value added.

Step 1: Defining the appropriate country specific aggregation level.

A high level of sector detail does not necessarily improve the accuracy of GHG projections. Increasing the level of detail often involves additional problems:

- historical data are difficult to obtain at low aggregation levels
- establishing a statistical relationship with the global economy (GDP) is difficult at low aggregation levels.
- unless specific additional information is available, one is often forced to use the same trends for different activities within one sub-family. In this case the low aggregation level does not provide any value added.
- the economy is constantly changing. New activities (products, production methods) arise at the cost of existing activities. In practice (for psychological and political reasons) it appears to be difficult to develop down sizing activity scenarios while new activities are always granted with an optimistic view.

One common characteristic of energy intensive activities is that they produce huge amounts of GHG emissions compared to value added. Typical energy intensive industries are: iron and steel (in particular pig iron), clinker production, cracking activities (ethylene, propylene..).
Generally the principle can be used that individual industrial activities for which GHG emissions amounting to 5 % of total industrial GHG emissions should be handled individually and activity variables preferable expressed in physical units. Value added is a poor indicator of economic activity

For other sectors it is difficult to express economic activity in terms of physical output. Also output data expressed in monetary terms are scarcely available. If relevant output variables are not available it is recommended to express these activities in terms of value added.

Step 2: Defining activity projections

In principle activity projections should be consistent wit a macro-economic scenario. Economic consistency can be considered in two directions:
1. Industrial sectors produce value added and consequently contribute to GDP
2. GDP as the driving factor for demand of industrial goods.

A. Activities are expressed in physical quantities

The value added of these activities is limited. Economic consistency in the first sense is not relevant here. However, economic consistency in the second sense is still relevant. It

depends whether the production is mainly for domestic use or for exports. If the domestic market is dominant then analysis of historical data can be used as a framework. If the historical trend to GDP tends to be stable, this relationship and GDP projection can be based to produce activity projection. If this relationship does not demonstrate a stable relationship (based on graphical or statistical analysis), then this trend should not be extrapolated. More detailed levels in the macro-scenario can be used too (e.g. construction activities for cement production)
In exceptional cases it might be appropriate to keep this ratio constant at the latest observed level or at another level if the latest observed level seems to be exceptional.

Use of additional information:
Energy intensive sectors tends to be very capital intensive and maximum profitability is obtained when operating at full capacity. Capacity limits can be considered in projections. Large expansions require huge investments, involving new environmental permits. Independent industry experts can often provide useful insights too. Sometimes it is useful to contact industry representatives.

Activities are expressed as value added.

In this case activity data should be consistent with the macro-economic scenario as well. National statistical sources can be used or EUROSTAT national account statistics branches in 17 or 31 branches can be used.

Step 3: Energy efficiency improvements.

Historical energy efficiency improvements can be derived from historical activity indicators and sector fuel consumption statistics reported in CRF. Energy efficiency improvements are the result of technological innovation.

Step 4 : Emissions calculations
Emissions are calculated based on constant fuel shares and implied emission factors as specified in Table1.A(a)s2. Process emissions are calculated by multiplying the implied emissions factors of Table2(I).A-Gs1 and the activity data.

TIER 2 - Integration of industry in linear programming model for the electricity sector.

In TIER1 the focus is on the demand side (development of an activity scenario). In TIER 2 we add an additional focus on the supply side.
TIER 2 is based on an explicit representation of the technologies. This allows to

- explicitly introduce capacity limitations
- represent different options
- to evaluate the new technologies (cfr
- to have a consistent framework to evaluate CHP policies
- to model the interactions between industry and the electricity sector and between different industry sub-sectors (cfr. blast furnace gas use by power sector, slacks use for Cement production)
- To evaluate const-effectiveness of PAMs

Requirements: basic training in developing Markal -Times or Message model.

ANNEX

Nace codes for sector other industries

db: textile and textile products
dc: leather and leather products
dd: wood and wood products
dh: rubber and plastic products
dk: Manufacture of machinery and equipment n.e.c.
dl: Manufacture of electrical and optical equipment
dm: Manufacture of transport equipment
dn: Manufacturing n.e.c.