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# Climate change policies
# Analysis of sectoral changes in Europe

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Les chercheurs de l'Iddri, associés à Catherine Boemare du Cired, ont rédigé cette étude en juin 2004, avec le soutien de l'Ademe. Ce texte n'engage que ses auteurs. En mettant ce document en ligne sur son site, l'Iddri a pour objectif de diffuser des travaux qu'il juge intéressants pour alimenter le débat.

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## Analysis of sectoral changes in Europe

**Carine Barbier, Richard Baron, Michel Colombier** *(Iddri)*
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**With the support of Ademe**

*Paris, June 2004*

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**Executive summary**

This study addresses the following question, at the core of Europe's climate policy: Beyond the question of the European Union's ability to meet its emissions commitments under the Kyoto Protocol, are sectoral emissions trends displaying structural changes deemed necessary to reduce emissions, and to attain levels that are consistent with the UNFCCC greenhouse gas concentration stabilisation objectives? What lessons can we draw from emissions trends for the EU future climate policy?

Greenhouse gas emissions have been stable for the last decade, but mostly due to events and policy developments unrelated to climate policy, and unlikely to be reproduced in other countries: Germany's reunification, substitution from coal to gas in the United Kingdom driven by power market reform. We should not expect changes of such magnitude in the near future. The issue of our future climate policy hence requires a closer look at underlying trends.

Industry's direct emissions decreased thanks to constant improvements in energy efficiency and to the substitution of electricity to direct fossil fuel use. If we account for industry's indirect emissions through electricity consumption, industry's overall emissions have been roughly stable since 1994. It is hard to predict whether efficiency gains to come – be they triggered by the EU emissions trading scheme or else – will be enough to offset a recent increase in carbon-intensive materials demand such as cement, steel or glass.

In spite of efficiency gains in the residential sector, increasing floor space and level of equipment entail growing energy consumption. Smaller-size households – a phenomenon observed in Northern Europe during the 80s – are now spreading to Southern European countries and should be expected in new Member states as well. Only large-scale measures to retrofit the existing residential stock can help curb emissions trends in this sector, but few countries have taken such measures to date.

Turning to the tertiary/services sector, we find that value added and floor space grew significantly over the decade – 35% and 32% respectively in the EU-15. A growing share of the region's economic growth occurs in these activities and there again, energy efficiency improvements do not compensate for growing floor spaces. Electricity's penetration is particularly striking, due to the development of information technologies and air-conditioning. The majority of per-employee emissions in this sector are related to electricity consumption.

Transport's growth, especially freight, has been significant in all countries. The highest rates of traffic growth per unit of gross domestic product are in Spain and Portugal, two countries where rail infrastructure is fairly limited. CO2 emissions from transport grew by 18% in the EU between 1990 and 2000. The potential for energy efficiency improvements is important, but may be more than offset by traffic growth, growing engine displacement and new onboard equipment. Inverting emissions trends in this sector is the major challenge of EU's climate policy for decades to come.

Power generation's $CO_2$ emissions have decreased slightly in spite of strong demand growth. As mentioned above, the carbon content of electricity has been reduced markedly in the UK but also in Germany for historical reasons. Coal to gas substitution remains important and could bring about EU's total emissions by 5 to 10%. However, business-as-usual projections provided by DG-TREN show a 50% increase in consumption by 2030. If the promotion of combined heat-and-power and renewable technologies is already underway thanks to EU coordination, CO2 emission reductions from the sector as a whole will require ambitious policies to control electricity demand. It is difficult, at this stage, to evaluate the impact of the EU emissions trading scheme on the price of electricity and the effect of such price increase on overall demand.

Turning to the macro-economic and development outlook, there is still a gap between per capita income between Portugal, Spain and Greece and the rest of Europe, a gap that is not projected to decrease by 2030. Standards of living, however, converge more rapidly, without inducing important

energy efficiency gains, however. The share of coal in power generation remains important and road freight grows swiftly. On the whole, while their economic development is more recent, these countries have not "leap-frogged" to less energy-intensive technologies.

It is well-known that countries with economies in transition that are now Members of the EU host a significant potential for energy efficiency improvements. Yet their energy needs are also on the rise. Their per capita energy consumption is much lower than the EU-15 average and will remain so by 2030 according to the EC reference scenario. These countries amount to 12% of the region's total energy consumption and are therefore unlikely to affect Europe's overall energy and CO2 situation to any significant degree.

Our overall assessment is that Europe's primary energy demand continues to grow, especially in the residential-services and transport sectors. We do not observe any saturation in EU-15 energy needs. These countries' weight in the region's energy and GHG emissions being significant, their responsibility in undertaking effective climate change policy responses remains prominent.

In this context, incremental improvements of current policies may not be enough to achieve Europe's overall goal for 2008-2012, let alone to bring about more significant reductions in the future. There is henceforth a risk of a major drift in greenhouse gas emissions once all one-off and least-cost measures have delivered their potential reductions. It is therefore necessary to envisage real structural changes to ensure sustained emission reductions in the medium to long term. Curbing electricity and transport demand, and the renovation of existing buildings ought to be priority fields of action for Europe and its Member states if they wish to reduce emissions markedly in the future. While countries and situations do differ in many aspects, the threat of climate change requires that EU countries set aside arguments related to their "national circumstances".

Based on the analytical results presented in this study, Iddri seeks to launch an international discussion on post-Kyoto EU climate policy. Our goal is not to identify the format for the next international agreement, but to think about the building blocks of a robust EU climate policy.

**Synthèse**

Au-delà des interrogations sur la capacité de l'Union européenne à respecter ou non ses engagements de Kyoto, les tendances sectorielles actuelles indiquent-elles des changements structurels à même de réduire durablement les émissions de CO2 vis-à-vis de l'objectif ultime de la Convention sur le changement climatique de stabilisation de concentration de GES dans l'atmosphère ? Quels enseignements pour les politiques climatiques futures au sein de l'Union européenne ?

Si les émissions de l'Union européenne se sont stabilisées durant la dernière décennie, les raisons en sont principalement des événements extérieurs à la lutte contre le changement climatique, notamment la réunification allemande, et la réforme du secteur électrique au Royaume-Uni accompagnée par une substitution rapide du charbon par du gaz naturel. Il est peu probable que des événements de cet ordre se reproduisent. Pour évaluer les enjeux des politiques climatiques, les tendances de fond doivent donc être interrogées.

Les émissions directes de l'industrie ont décliné grâce à une amélioration constante de l'efficacité énergétique, mais aussi par une forte pénétration de l'électricité. Si on intègre les émissions indirectes liées à la production d'électricité, les émissions de $CO_2$ de l'industrie en Europe se sont à peu près stabilisées depuis 1994. En revanche, il n'est pas possible d'affirmer que les gains d'efficacité à venir – qu'ils soient le résultat de la Directive sur les permis d'émissions échangeables ou non - vont permettre de compenser l'apparente croissance de la demande pour des produits intensifs en carbone tels que le ciment, l'acier ou le verre.

Malgré les gains d'efficacité énergétique, la consommation d'énergie dans le secteur résidentiel continue d'augmenter dans la plupart des pays du fait de l'accroissement des surfaces et du confort. La réduction de la taille des ménages -qui fut significative dans les années 80 dans le nord de l'Europe- se poursuit, elle s'étend maintenant au sud de l'Europe et se produira probablement dans les nouveaux pays membres. Seules des politiques d'ampleur de réhabilitation du stock de logements existants permettraient d'inverser les tendances d'émissions dans ce secteur, mais très peu de pays se sont jusqu'à maintenant engagés dans cette voie.

En dix ans, la valeur ajoutée et les surfaces dédiées aux activités tertiaires se sont accrues respectivement de 35% et de 32% dans l'Europe des 15. La croissance économique se fait essentiellement par le développement du tertiaire. Les gains d'efficacité énergétique ne compensent pas l'effet parc, et la pénétration de l'électricité y est particulièrement importante du fait du développement des équipements électriques et de la climatisation. En moyenne en Europe, la majorité des émissions de $CO_2$ par employé du tertiaire sont des émissions indirectes dues à la consommation d'électricité.

Les transports connaissent une croissance majeure dans tous les pays, elle est particulièrement soutenue pour le transport de marchandises. Les taux les plus élevés de trafic de marchandises par unité de PIB sont en Espagne et au Portugal, pays où les infrastructures ferroviaires sont très limitées. Les émissions de $CO_2$ du transport se sont ainsi accrues de 18% en dix ans dans l'UE-15. Si les potentiels d'amélioration de l'efficacité énergétique des véhicules sont encore importants, ils ne doivent pas être annihilés par la croissance continue des trafics, des puissances et des équipements des véhicules. L'inversion des tendances d'émissions dans ce secteur est un défi majeur pour l'Union européenne dans les décennies à venir.

Les émissions de $CO_2$ sur secteur électrique diminuent légèrement malgré une forte croissance de la demande. Comme nous l'avons dit plus haut, le contenu en carbone de la production d'électricité a fortement baissé en Allemagne et au Royaume-Uni pour des raisons historiques. Le potentiel de substitution du charbon par le gaz est encore important et pourrait permettre de réduire les émissions totales de l'UE-15 de 5 à 10%. Cependant, selon le scénario de référence à l'horizon 2030 (DG TREN), la consommation d'électricité pourrait croître de 50% à cet horizon. Si une dynamique de développement des énergies renouvelables et de la cogénération est à l'œuvre en Europe grâce à

l'impulsion de la Commission européenne, renforcer significativement la place de ces énergies dans la production d'électricité n'est possible que simultanément à une politique ambitieuse de maîtrise de la demande. Dans le contexte actuel, il est difficile de mesurer quel sera l'impact de la Directive sur les permis d'émissions négociables sur ce secteur, en particulier sur le prix de l'électricité et une éventuelle contraction de la demande d'électricité.

On constate un écart persistant entre les revenus par habitant des pays du sud de l'Europe (Portugal, Espagne, Grèce) et ceux du reste de l'Europe ; écart qui va semble-t-il se maintenir à l'horizon 2030. Néanmoins, les modes de vie convergent plus rapidement induisant des besoins énergétiques proches de ceux du Nord, sans pourtant bénéficier de technologies performantes. La part du charbon dans la production d'électricité est importante, et comme nous l'avons vu, le transport routier croît à vive allure. En matière de sobriété énergétique, ces pays ne semblent donc pas faire mieux que le reste des pays de l'Union dont le développement est plus ancien.

Le potentiel de gains d'efficacité énergétique des dix nouveaux membres de l'Union Européenne est bien entendu élevé ; mais les besoins non satisfaits le sont tout autant. Leur consommation d'énergie par habitant est aujourd'hui plus faible que celle de l'Europe des 15, et le restera à l'horizon 2030 selon le scénario de référence de la Commission européenne. Ces pays représentent 12% de la consommation énergétique de l'Europe à 25, ils pèsent donc relativement peu dans le bilan global de l'UE. Une politique de limitation de la croissance des émissions de CO2 dans ces pays est nécessaire mais ne modifiera pas radicalement la donne du point de vue des tendances d'émissions de l'Europe dans son ensemble.

Nous constatons donc que partout en Europe, la demande d'énergie continue de croître, tout particulièrement dans le résidentiel-tertiaire et les transports. Nous n'observons pas de phénomène de saturation des besoins énergétiques dans les pays anciens membres de l'UE. Leur poids dans les émissions globales de l'UE restera dominant dans le futur, et donc leurs responsabilités du point de vue de la mise en œuvre des politiques de lutte contre le changement climatique sont majeures.

Dans ce contexte, il n'est pas certain qu'un simple renforcement incrémental des politiques déjà en place permettra à l'Europe de respecter ses engagements pour 2008-2012, et encore moins de s'orienter vers une inflexion significative de ses émissions. Le risque est de devoir faire face à une nouvelle dérive beaucoup plus incontrôlable des émissions une fois que les mesures à faible coût et non reproductibles déjà prises auront épuisé leurs effets. Ce sont donc de réels changements structurels qu'il s'agit d'envisager. L'inflexion de la demande d'électricité, de la demande de transport et la réhabilitation des logements existants sont les trois chantiers prioritaires que l'Europe et ses pays membres doivent affronter pour espérer pouvoir infléchir leurs émissions à long terme. Si les situations sont diversifiées selon les pays et marquées par des histoires particulières, invoquer des « circonstances nationales » difficiles paraît aujourd'hui dérisoire au regard des enjeux du changement climatique.

C'est à partir de ces résultats que l'Iddri souhaite lancer une réflexion internationale sur l'après-Kyoto en Europe, non pour envisager le format d'un accord international, mais sur ce que devraient être les fondations d'une politique climatique européenne robuste.

## I – Introduction – Purpose of this paper

In 2004, climate policy is at critical juncture at both international and domestic levels. The Kyoto Protocol has yet to enter into force. Meanwhile, the EU has reiterated its intention to meet the Kyoto objectives and is moving forward with the implementation of wide-ranging policies such as the EU emissions trading system (ETS) and the directive linking this system to project-based mechanisms created by the Kyoto Protocol. European countries are also considering longer term emission objectives towards the ultimate objective of the Framework Convention on Climate Change, and in some cases have specified long-term goals, e.g., the UK, Germany and France.

A quick look at EU countries' energy-related $CO_2$ emissions in recent years suggests that the near-term emission reduction objectives set at Kyoto might not be achieved – that is, without resorting to the Protocol's flexibility mechanisms. What may be of concern, however, is the possibility that the underlying capital, technology and behaviour dynamics lead to upward rather than downward $CO_2$ emissions beyond 2012. The purpose of this discussion paper is to take a closer look at sectoral trends across EU countries (including acceding countries, albeit at a lower level of detail) and try to identify which activities represent the main challenges for Europe's climate policy objectives. Ultimately, our intent is to initiate a discussion about new policies and measures that may be required to meet these challenges and the role of EU coordination in this field.

## II – The CO2 emissions trends by sector in the EU-15 since 1990

Meeting greenhouse gas targets agreed at Kyoto requires that each country allocate, explicitly or not, the mitigation burden to individual sectors. One way to evaluate greenhouse gas mitigation policies, notwithstanding the possibility to rely on Kyoto's flexibility mechanisms, is to take a sectoral look at emission trends to distinguish so-called one-off mitigation options that may have already been pursued or are awaiting a clear policy signal, from those that will require more structural efforts in order to deliver significant reductions in the medium term. Trend analysis alone is not enough for this purpose. Some evaluation of policies and measures that have been or may be implemented in countries is also necessary, however difficult this task may be. An attempt at this is done in the next section. This section takes a cold look at sectoral emission trends.

The analysis relies mainly on EEA reports, the Enerdata world database and IEA statistics. This analysis is completed by a projection of energy supply and demand in the European Union on the basis of current trends and policies, including those in the process of implementation by the end of 2001 (hereafter referred to as the "Baseline scenario").[1] The effect of the EU Directive on GHG emissions trading is therefore not taken into account in this projection.

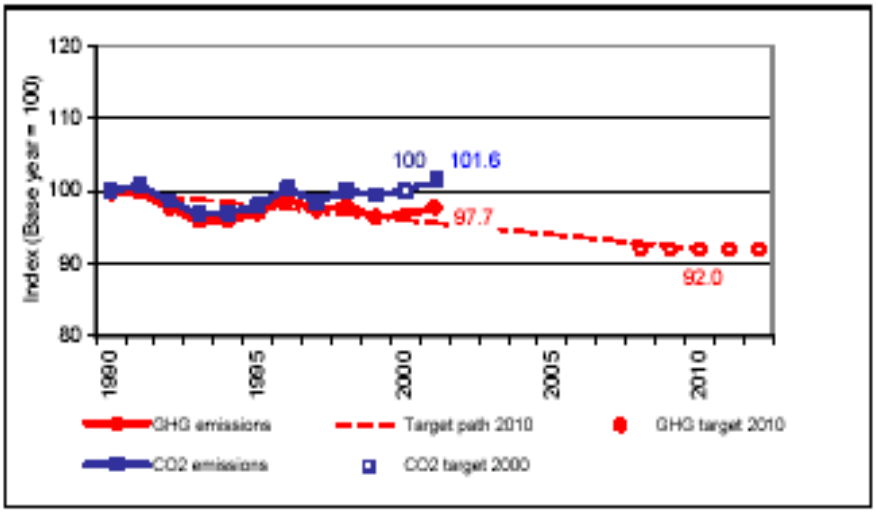
Before going any further, the EEA provides a central insight in EU's emission trends:

*"The European Union and many of its Member States will fail to meet their Kyoto Protocol targets for limiting greenhouse gas emissions on the basis of the domestic policies and measures implemented or planned so far, according to new projections compiled by the European Environment Agency. The main reason is a runaway increase in emissions from transport, especially road transport.t"*[2]

In 2001, the EU had cut its overall emissions by 2.3 % below 1990 levels (Figure 1). The latest EEA projections, however, show that existing domestic policies and measures – concrete initiatives already being implemented at EU or national level – will reduce the EU's total emissions by only 0.5 % below 1990 levels in the year 2010, leaving it 7.5 % short of the Kyoto target.

[1] European Commission – DG Energy and Transport, « European energy and transport trends to 2030", January 2003.
[2] EEA news release, Copenhagen, 2 December 2003.

*Figure 1* : **Actual EU GHG emissions compared with target for 2000 and 2008-12**

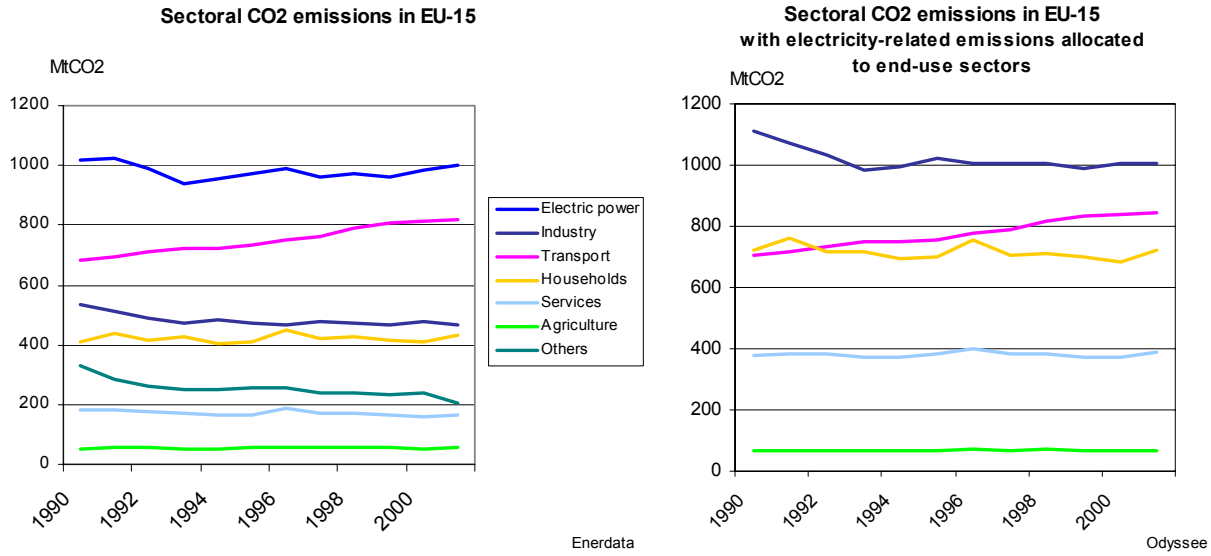



*Source : EEA, 2003.*

Between 1990 and 2000, the average GDP per capita in the EU-15 grew by 1.7% and it is expected to grow by 2.2% between 2000 and 2010 according the European "Baseline scenario". Interestingly, this does not imply any convergence in levels of GDP per capita across EU member States over these two periods. On the contrary, the trends of GHG emissions per capita are more or less converging towards 10-11 tons of CO2 equivalent per capita, which is roughly the level implied by the Kyoto target for the EU-15 in 2010 (about 10 tCO2 equiv. per capita).

Power generation and transport each amount to one third of total energy related-CO2 emissions in EU-15 (figures 2 and 3). Emissions from transport are growing rapidly and could exceed those of power generation, according to the baseline scenario of DG TREN. The figure 3 shows end-use sectors' emissions once electricity-related emissions are apportioned to electricity users: industry's emissions are then twice their direct emission level. It also shows that the households sector is responsible for a significant portion of the region's CO2 emissions.

*Figures 2 and 3*



The CO2 picture differs radically across countries, mainly because of the disparate electricity generation profiles. If we exclude CO2 from electricity production, transport is by far the largest emitter and the most rapidly growing in all countries over 1990-2000 (Table 1). Industry's emissions decreased over this period except in Spain, UK and Portugal. As we will see later on, emissions in the tertiary sector (services) grew rapidly in Portugal, Spain and Greece, but the share of this sector in the total of CO2 emissions of these three countries remains quite low.

*Table 1:* **Trends of CO2 emissions by sector 1990-2000**

| | Power gen. | Industry | Transport | Households | Tertiary |
|---|---|---|---|---|---|
| Germany | -18,6% | -24,0% | 14,3% | -7,2% | -39,0% |
| Belgium | -1,2% | -12,4% | 25,9% | 8,6% | 2,6% |
| Spain | 39,6% | 13,2% | 47,9% | 29,9% | 80,6% |
| France | -8,7% | -7,7% | 23,2% | -0,4% | 9,0% |
| Greece | 32,7% | -3,4% | 20,9% | 61,8% | 48,1% |
| Italy | 10,8% | -14,2% | 19,5% | -0,3% | 12,9% |
| Netherlands | 18,8% | -1,9% | 33,9% | -1,5% | 0,3% |
| UK | -15,8% | 1,2% | 13,6% | 10,4% | -7,0% |
| Portugal | 41,1% | 16,0% | 73,7% | 20,8% | 117,5% |

*Source Enerdata*

## II.A – Industry (excluding power generation and refining)

Between 1990 and 2001, industry's total energy-related $CO_2$ emissions decreased by about 10%, and accounted for 17% of the region's total. Oil and gas each account for roughly 40% of the total, coal for the remaining 22%. While some sectors have undergone declines in industrial production, and there have been continuing improvements in energy efficiency, the reduction in $CO_2$ emissions is also caused by a substitution of direct fossil fuel use by electricity use, in effect partly displacing $CO_2$ emissions outside the non-energy industry activities.

Sorting out the effect of this substitution on industry's direct and indirect $CO_2$ emissions is a difficult task, beyond the scope of this work. In some cases, electricity use has brought with it significant efficiency improvements and reduced overall emissions, including those associated with increased electricity use (e.g. steel produced through the electric arc furnace process has a carbon content of 0.5 tCO2 per tonne in Europe, against 2.1 $tCO_2$ for a tonne of steel coming out of a basic oxygen furnace process).[3]

A country-by-country review of industrial $CO_2$ emissions reveals striking differences: Germany recorded a 30% reduction between 1990 and 2001, a decline of more than 50 $MtCO_2$. The United Kingdom's manufacturing and construction's emissions decreased by 17% (-14 Mt), while Spain's increased by 30% (+13 Mt), over the same period. The *table 2* summarises this information, including the evolution of electricity demand over the decade, for key European countries. The next figure illustrates the contribution of various industrial activities to CO2 emissions and energy use, for selected countries.

*Table 2:* **Industry $CO_2$ emissions, fossil fuel and electricity use (1990-2000), selected countries**

| | $CO_2$ emissions in 2001 (Mt) / 1990-2001 trend | Fuel use in 2000 (Mtoe) / 1990-2000 trend | Electricity use (Mtoe) / 1990-2000 trend |
|---|---|---|---|
| Germany* | 126.6 -29.5% | 39.85 -16.4% | 17.96 **+7.7%** |
| France | 78.1 -2.6% | 25.9 -3.4% | 11.2 **+23.9%** |
| Belgium | 35.7 **+19.2%** | 10.23 +8.3% | 3.4 **+29.6%** |

[3] OECD (2003)

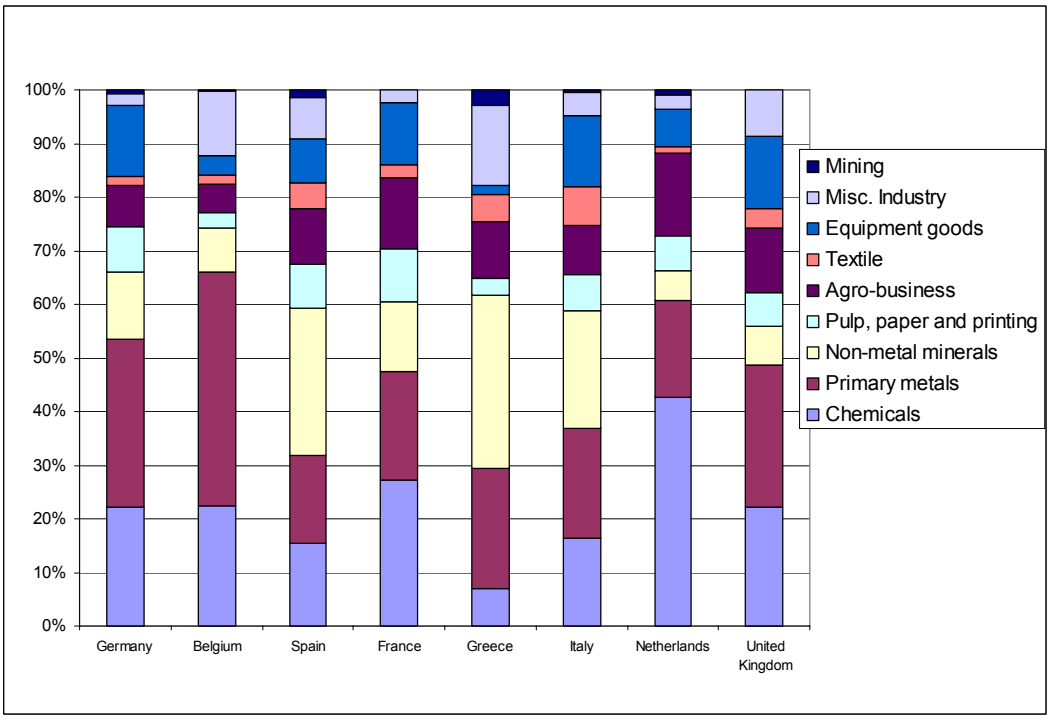
| | | | | | | |
|---|---|---|---|---|---|---|
| Spain | 58.9 | **+29.6%** | 17.68 | +15.2% | 7.24 | **+32%** |
| Italy | 77.42 | -9.7% | 27.53 | +2.3% | 11.6 | **+23%** |
| Netherlands | 34.65 | **+2.2%** | 11.9 | +5.6% | 3.5 | **+23.5** |
| United Kingdom | 69.41 | -17.2% | 23 | -15.5% | 9.6 | **+12.3%** |
| Total* | 480.8 | -10.7% | 156.05 | -3.8% | 64.52 | **+18.15%** |
| EU total | 554.1 | -9.7% | | | | |

Mtoe: million tonnes of oil equivalent.
* 1991-2000 variations in fossil fuel and electricity consumption for Germany and total.
Source: Enerdata; IEA (2003).

As stated above, the increase in industry's electricity use, at the expense of direct fossil fuel consumption, moved $CO_2$ emissions outside industry into the power generation sector. In 2000, for the selected countries shown above, the increase in electricity use from 1990 levels is estimated to add some 45 $MtCO_2$ to the industry's direct emissions. These direct emissions from fossil fuel use, for the same group of countries, were reduced by 45.8 $MtCO_2$. Such comparisons must obviously be treated by care; there are structural factors that ought to be taken into account when these figures: not all reductions in industry's direct emissions were triggered by a shift to a process using electricity, and some countries recorded both an increase in direct emissions and in electricity use… But on aggregate, with the present $CO_2$ content of power generation in these countries, the contribution of industrial activity to CO2 emissions from energy has remained fairly stable, while direct emissions would suggest a drop since 1990.

In what follows, we do not attempt to track emissions related to industry's electricity use (an exercise that is made difficult by the lack of appropriate data on specific sectors' electricity use), but we do include, when available greenhouse gas emissions other than $CO_2$ from fossil fuel use. For the sake of simplicity and comprehensiveness, we take broad sectoral look across countries, while we recognise the diversity of each country's situation on specific sectors, as is shown in their contribution to industry's CO2 emissions below.

*Figure 4:* **Sectoral breakdown of final energy consumption, including electricity (selected EU countries, 2001)**



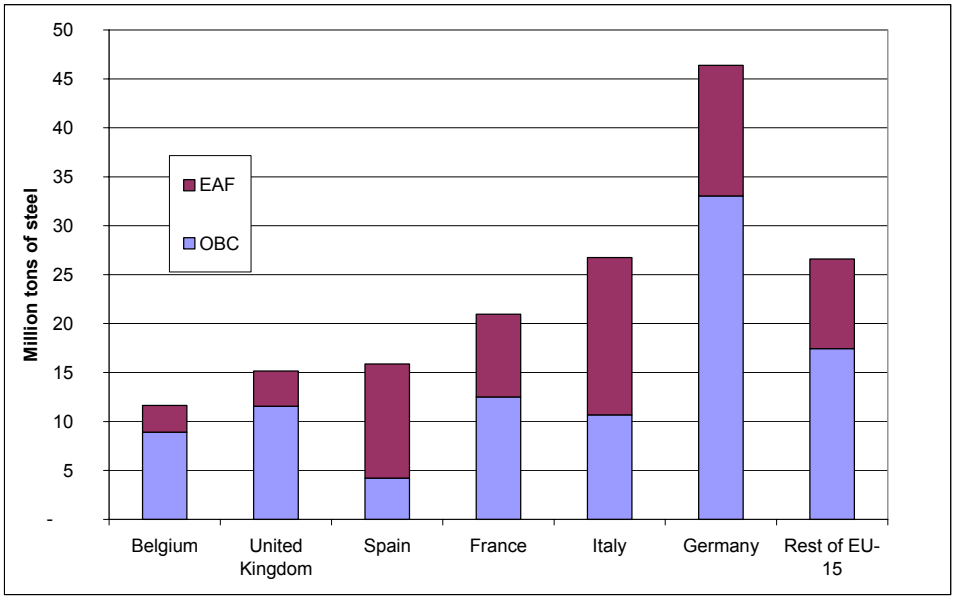

Source: Enerdata.

## II.A.1 – Steel

The European steel sector has undergone a minor yet environmentally significant shift in its production processes over the decade. The share of the more $CO_2$-intensive basic oxygen furnace decreased from 68% to 59%. This production route has been more and more replaced by electric furnaces.[4] Even with all account taken of upstream emissions in the power sector, the arc furnace route releases about one quarter the emissions released through the basic oxygen furnace (0.5 $tCO_2$ per tonne versus 2.1 $tCO_2$).[5]

The products of these two processes are not totally substitutable and the economics of the electric furnace route hinges on the availability of scrap steel at acceptable prices. In addition, the arc furnace route has not been competitive for the production of flat steel products at the early stages, although continuous improvements are achieved.[6] For this reason, it is not clear whether the sector can develop this route much beyond its current share, under existing conditions. The *figure 5* shows the extent of the use of the electric arc technology in EU-15 countries.

*Figure 5*: **Steel production in electric arc furnaces and oxygen-blown converters in EU-15 (2000)**




Source: IISI (2003).

Overall, the improvements in energy efficiency over the decade (1.5% per year on average in the EU) have more than offset the growth in production (1.09% per year).[7] Energy-related $CO_2$ emissions from steel have decreased by 24% between 1990 and 2000 for the EU's five main steel producers (France, Germany, Italy, Spain and the UK), down to 80.9 $MtCO_2$, an encouraging figure given the relatively high level of EU steel production that year (163 Mt, against 159 Mt in 2001). That said, some of this decline is caused by the closure of plants, e.g. in the United Kingdom where production declined from 18.5 Mt in 1997 to 11.7 Mt in 2002.[8] The UK's basic oxygen furnace production declined by some 5 Mt. This represents a 10 $MtCO_2$ reduction over that period.

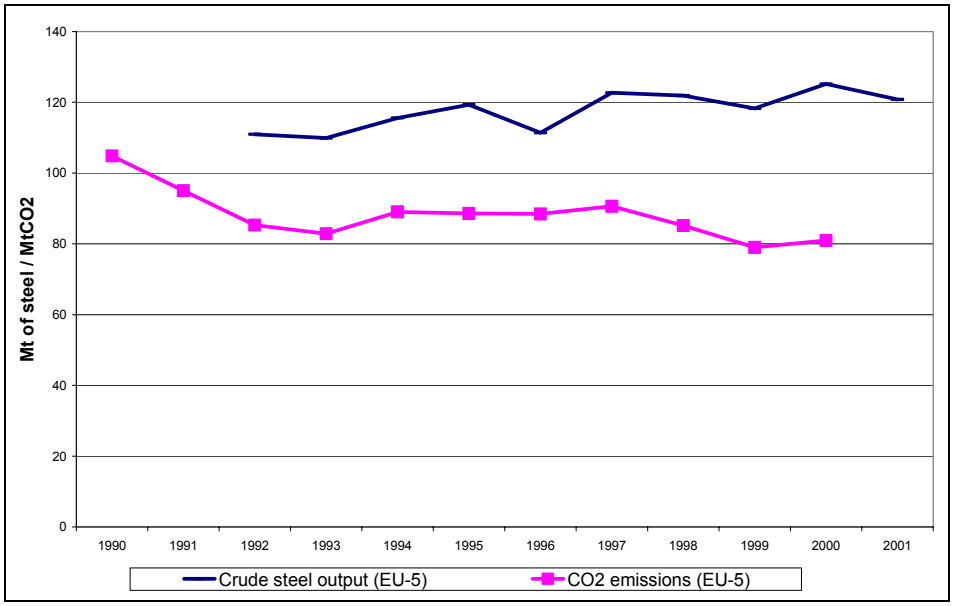
The *figure 6* shows the evolution of steel and $CO_2$ emissions for the five largest steel producers in the EU over the period, where some of these reductions can be observed.

[4] IISI (2003)
[5] OECD (2003)
[6] ILO, website extraction March 2004.
[7] Odysee database on energy efficiency indicators, Ademe, 2003.
[8] Iron and Steel Statistics Bureau (2004).

In addition to energy-related $CO_2$ emissions, iron and steel production also releases process-related $CO_2$, which have also followed a downward path since 1990 (total process $CO_2$ emissions from the metal industry, mostly iron and steel, declined from 25.7 to 23.8 $MtCO_2$ equivalent between 1990 and 2001 in EU-15).[9]

The reported production levels in 2003 and early 2004 for Europe and the world confirm the very cyclical nature of this activity with a strong surge in demand in 2004 (+8.4% increase in primary steel production on an annual basis). It is therefore too early to tell whether the seemingly steady European production level, with a shift towards the less $CO_2$-intensive electric arc route will prevail over the near term increase in demand, when it comes to overall GHG emissions in this sector in the longer run.

*Figure 6:* **Steel production and related $CO_2$ emissions (excl. power generation) for France, Germany, Italy; Spain and the UK**




Source : Iron and Steel Statistics Bureau

## II.A.2 – Chemicals

The petrochemicals and chemicals sector combines a very diverse range of activities, from ammonia to adipic acid production. It releases greenhouse gases both through energy use ($CO_2$) and industrial processes, especially $N_2O$ in the production of adipic acid and nitric acid, but also $CO_2$. The following table gives an idea of the trend in emissions between 1990 and 2000/2001.

*Table 3 :* **Greenhouse gas emissions from the chemical sector for EU-15 (1990 – 2000/2001)**

| | 1990 | 2000* (% change) |
|---|---|---|
| Energy-related $CO_2$ emissions (Mt $CO_2$) | 151.2 | 141.5 (-6.4%) |
| $N_2O$ from industrial processes (Mt $CO_2$ equivalent) | 106.1 | 49.2 (-53.7%) |
| $CO_2$ from industrial processes (Mt $CO_2$) | 12.9 | 10.8 (-16.3%) |

* Data is provided for 2001 for industrial process emissions of $N_2O$ and $CO_2$
Sources: IEA (2002), EEA (2003) p. 52-53.

Nitrous oxide emissions have been reduced quite dramatically in Europe over the decade. The IPCC Third Assessment Report highlights that various processes exist to reduce nitrous oxide emissions by

[9] EEA(2003), page 53.

90 to 98% at very low cost, especially in adipic acid production;[10] it also adds that "five major adipic acid manufacturers worldwide in 1991 to 1993 have agreed on information exchange and a substantial emission cut before the year 2000." The past evolution of $N_2O$ emissions in Europe probably reflects this effort. When greenhouse gases are totalled over the sector, this amounts to a 25% reduction. With proper incentives, further reductions in $N_2O$ should be reachable at low cost for the industry.

**II.A.3 – Cement, glass and other non-metal minerals**

Detailed on production levels for cement, ceramics, bricks and glass are hard to find, so our analysis is limited to a consideration of emission trends at EU level. This group of industrial activities has a high level of process-related CO2 emissions (especially in cement and glass production): they amounted to 106 $MtCO_2$ in 2001. In 1990, process-related emissions of France, Italy, Germany, Spain and the United Kingdom amounted to 81 MtCO2 while direct energy-related emissions amounted to 72 Mt. Process-related emissions can be lowered through the use of alternative inputs (e.g. a larger share of recycled white glass in glass production, the use of additives in clinker production for cement).[11]

Total emissions from these sectors have been on a declining trend since 1990, although they hit a low level in 1996 and have been growing slightly since then. This is clearly a cyclical activity, very much dependent on the construction sector where most if not all cement is consumed, and also a large consumer of glass. Glass demand is also driven by demand for cars, also driven by overall GDP growth.

It is difficult to assess at this stage whether the slight decline in emissions (-1% in process emissions over 1990-2000, -6% in energy-related emissions, excluding those from electricity use) is a sign that efficiency and process improvements are supplanting volume growth in setting the trend of future $CO_2$ emissions in the minerals industry. Data for 2002 and 2003 should help draw a clearer picture, as emissions seem to be on an upward trend since 1996, following cement production, but with a slight decoupling between production and emissions.

**II.A.4 – Paper and pulp**

The paper and pulp sector is not nearly as large a source of industrial greenhouse gas emissions as its heavy industry counterparts. Total direct energy-related $CO_2$ emissions for this sector amounted to 32 $MtCO_2$. Emissions have grown slightly over the decade (+2.2%). However, as is the case in other industrial sectors, the sector's electricity consumption rose rapidly, which implies rising indirect emissions. On the whole, the sector has witnessed an overall improvement in energy efficiency (-8.8% between 1990 and 2000, measured with tons of oil equivalent per ton of output, including electricity consumption). The paper and pulp industry argues that it is already a large consumer of renewable energy and relies heavily on combined heat-and-power. It stresses however that further efficiency improvements would be feasible through co-generation, provided that it has appropriate access to the electricity grid to balance its surplus.[12]

[10] Chapter 3 of the IPCC's working group III quotes mitigation costs between US$20 and US$60/tN2O, that is less than a dollar per tC, or less than 27 US dollar cents per $tCO_2$ (IPCC, p. 213).
[11] OECD/IEA (2001)
[12] CEPI (2003)

## II.B – Housing and tertiary sector

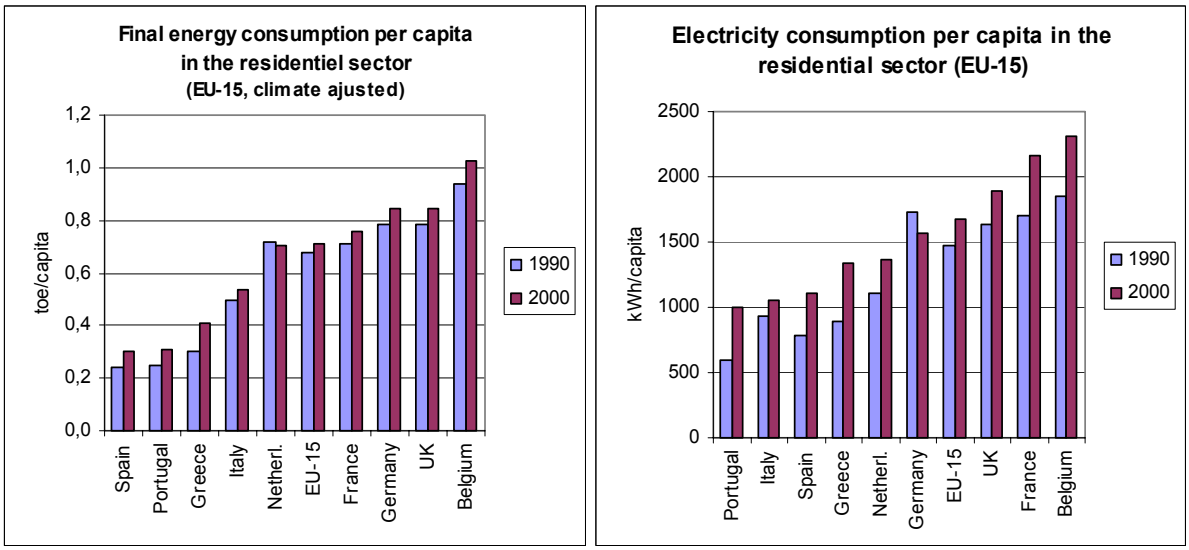
### II.B.1 – Households

The residential sector has experienced a continuous growth in the number of dwellings, at a higher rate than population growth, an increase in the average size of dwellings (from 85 to 89 square meters between 1990 and 2000), and improvement in comfort level. In parallel, the number of person per dwelling decreased in Greece, Italy and Spain, as was observed earlier in the rest of Europe, and is now approaching the European average of 2.5 persons per home.

Space heating is still by far the largest end-use in EU countries (70%), followed by water heating (14%) and electrical appliances and lighting with 12%[13], albeit with variations from country to country, a reflection of climate conditions among others. The share of space heating varies between 75% in Germany and The Netherlands and 30% in Portugal.

The level of energy consumption per square metre in EU-15 declined until 1995 and has stabilised since, at some 20 kg of oil equivalent. An energy efficiency index developed by Enerdata indicates that energy efficiency in the residential sector improved by around 5% between 1990 and 2000 in most European countries[14]. This improvement does not, however, offset increases in dwelling size and comfort: per capita energy consumption in the residential sector has increased in all countries (except the Netherlands), with a more significant increase in electricity demand. On the whole, total energy demand in the residential sector grew by 7% in EU-15 over the period.

*Figures 7 and 8: Energy in the residential sector, EU-15*



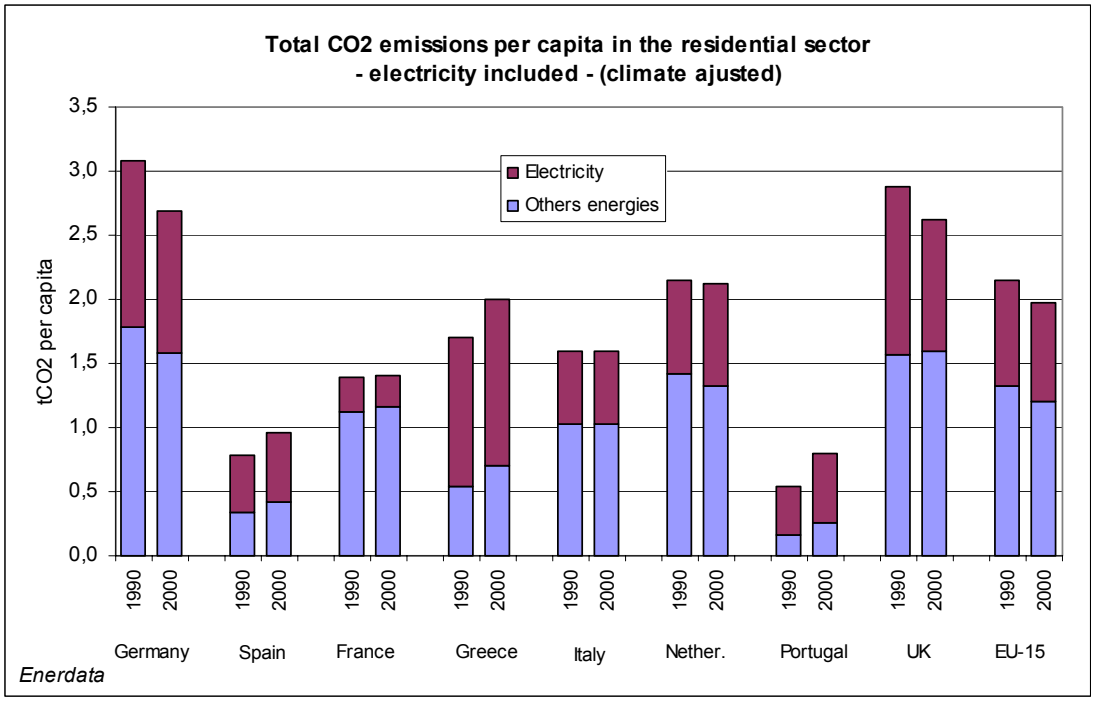

Source : Odysee

On a per-capita basis, residential electricity consumption, increased by 14% in the EU between 1990 and 2000. It increased by more than 50% in Greece and Portugal; but in absolute terms, the largest increased were in France and Belgium (+450 kWh/capita). The average efficiency of large electrical appliances improved by 20-30% since 1990, but the increase in appliance ownership offset almost 60% of the technical gains[15].

[13] ENERDATA sa, FhG/ISI, Energy efficiency in the European Union 1990-2001, June 2003.
[14] This index aggregates trends in different end-uses on the basis of their share in total consumption (space heating: unit consumption per m2, large electric appliances: specific consumption in kWh/year.appliance, water heating and cooking: unit consumption per dwelling).
[15] ENERDATA sa, FhG/ISI, Energy efficiency in the European Union 1990-2001, June 2003.

$CO_2$ emissions (not including electricity) from households decreased by 3% between 1990 and 2000 in the EU and by 8% if electricity is included (Figure 9). Reductions were mainly due to fuel switching to natural gas and electricity (emissions are then recorded in the power generation sector), and to energy efficiency improvements (thermal insulation).

*Figure 9*



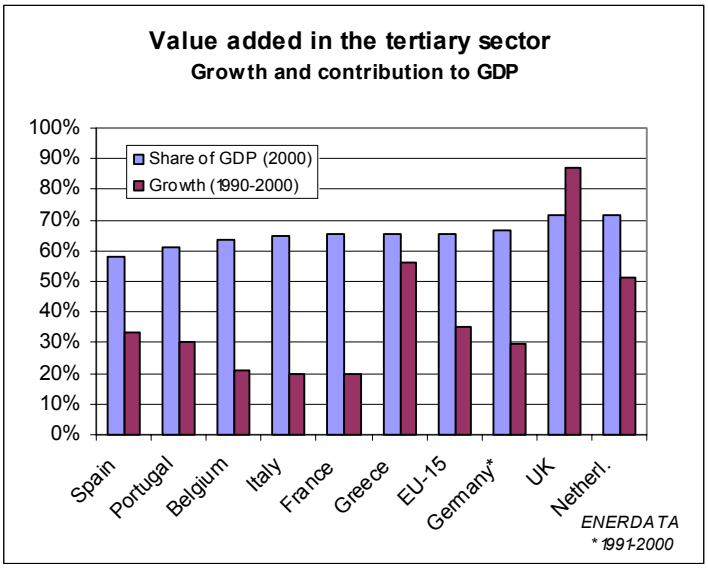

In the Primes baseline scenario, the growth of total energy demand by households is expected to slow down (+0.6%/year on average between 2000 and 2030), although energy needs for electrical appliances and air conditioning are foreseen to grow rapidly (+2% per year and +3.4% per year respectively). In 2030, the main fuel will be natural gas (46% of final energy demand), thermal solar energy is expected to stay marginal (1%)[16]. $CO_2$ emissions from the residential sector is expected to be stable over the period (about 430 $MtCO_2$), as increases in electricity use results in increasing emissions measured elsewhere, namely in power generation.

### II.B.2 – Tertiary sector

The tertiary sector contributes 66% of total gross domestic product in EU-15, a contribution that is roughly the same in all countries (Figure 10). Since 1990, it has grown most rapidly in the UK, the Netherlands and Greece. Over the last decade, in EU-15, the value added and average space size in the sector grew by 35% and 32% respectively, while energy demand grew by 13% only. The share of the tertiary sector in energy consumption remained stable throughout the decade (at about 12%), thanks to improvements in energy intensity.

[16] EU-15 Energy and Transport outlook to 2030, p 60.

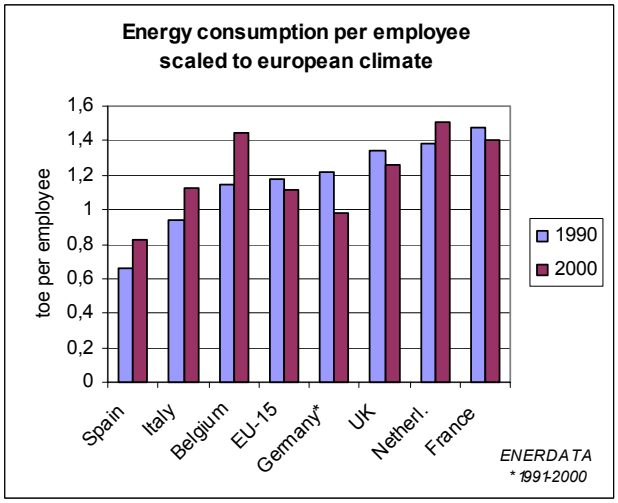
*Figure 10*

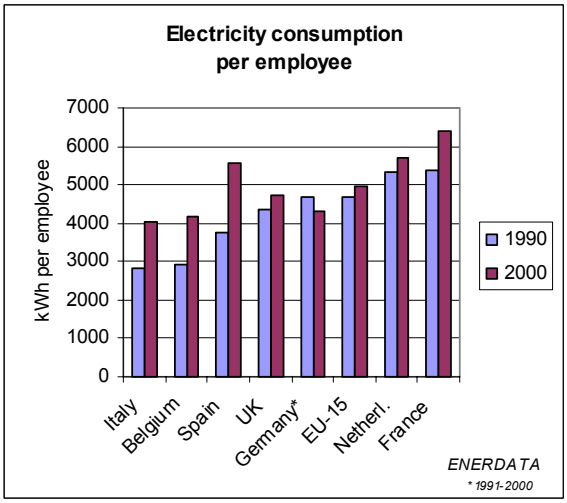



Non-market services (including health, education, public services, etc.) are the most energy intensive activities within this sector, but they should record only a modest growth in floor area between now and 2030 (0.8% per year).[17] These are followed by market services (offices, tourism, telecommunications, etc.), where floor space has been growing by 2% per year. Trade (floor space increasing at 1,9% pa) is the least energy intensive.

The share of electricity in total energy consumption increased from 37% in 1990 to 41% in 2000 (against 22% in 2000 in the residential sector). The per employee consumption, including air-conditioning, decreased slightly in the EU-15, but this overall trend hides disparities across European countries. Consumption per employee increased in Belgium, The Netherlands, Spain and Italy. Electricity consumption per employee increased in all the countries except Germany. The higher level is observed in France. The electricity demand growth is driven by the increasing use of electric appliances and the rapid penetration of air conditioning. Under EU Baseline scenario assumptions, they are expected to increase respectively by 3% pa and 2.3% annually in 2000-2030.

*Figures 11 and 12: Energy in the tertiary sector, EU-15*

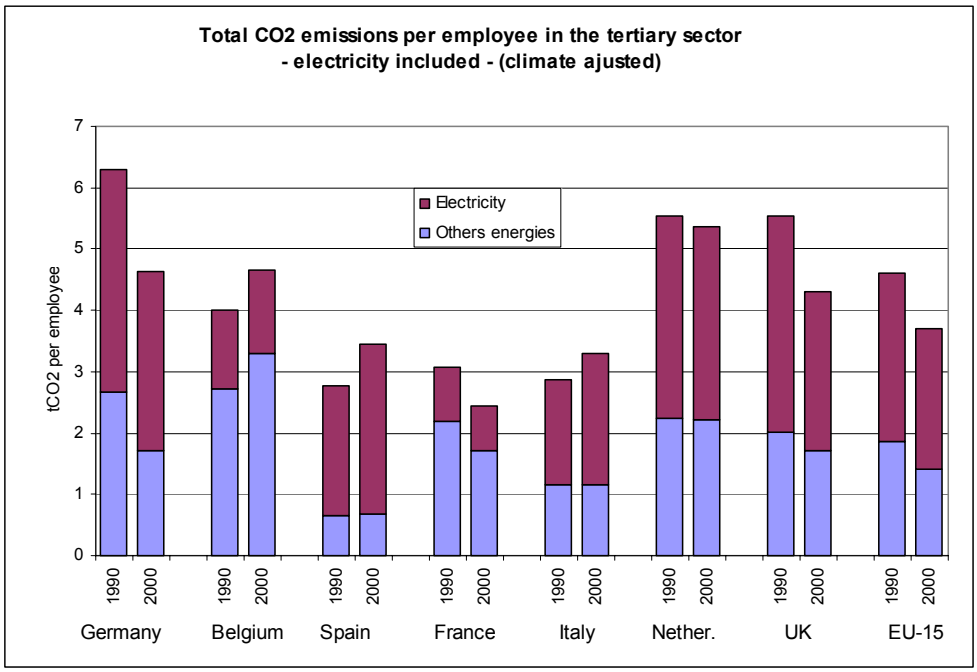



[17] ENERDATA sa, FhG/ISI, Energy efficiency in the European Union 1990-2001, June 2003.

As in the residential sector, energy efficiency improvements and the fuel switching do not compensate for the growth in the sector's overall activity. $CO_2$ emissions declined slightly between 1990 and 2000, but are expected to grow by 10% between 2000 and 2030 in the baseline scenario. The substitution of fuel oil by gas was quite important during the last decade. The share of liquid fuels was 18% in 2000 and gas 32%, leaving little scope for further substitution. $CO_2$ emission reduction in this sector can only come through strong efforts on energy conservation in building, cogeneration development and lower carbon intensive power production. This sector is also less statistically known than all other energy consumption sectors, which complicates policy appraisals.

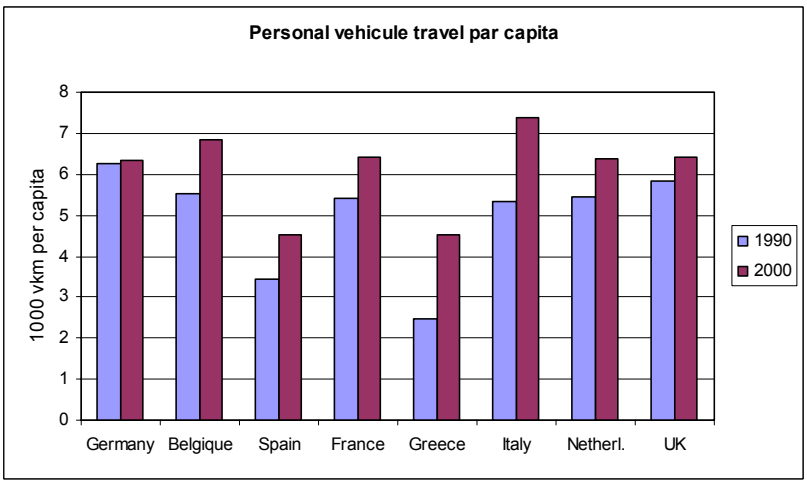
*Figure 13*




## II.C – Transport sector

The transport sector is a matter of great concern when it comes to greenhouse gas emissions, especially because it is characterised by a significant inertia, driven by behaviours, but also infrastructures and land-use patterns.

*Figure 14*

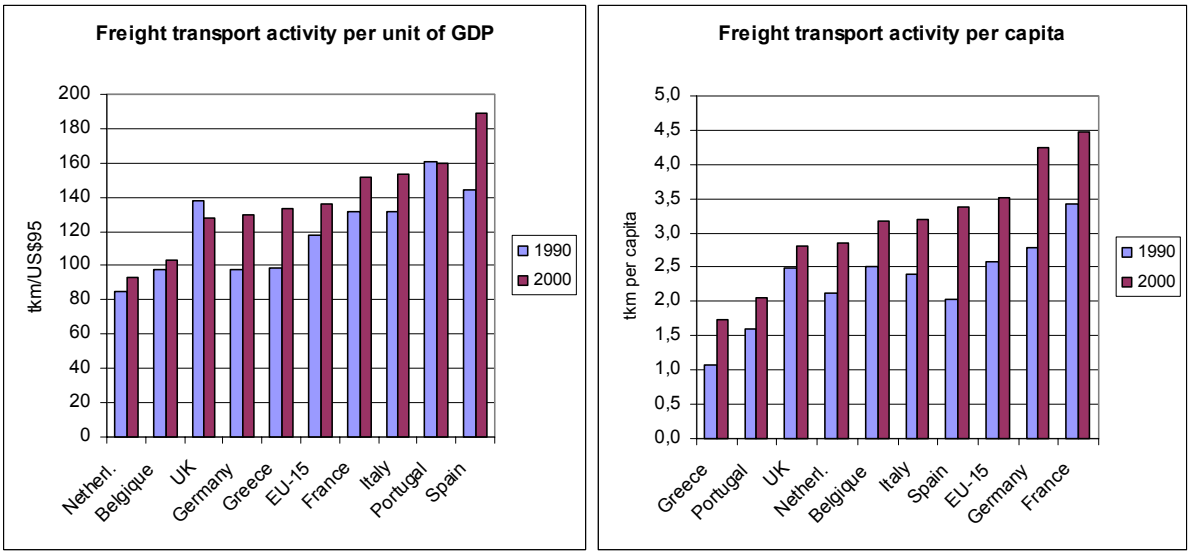



During the 1990s, passenger travel increased at a rate close to GDP growth. The number of cars per capita in the EU rose by about 20% between 1990 and 2000. The highest rates of car ownership per capita are found in Italy (0,56) and Germany (0,52). However the rate of increase slowed down compared to the 1980s, a possible evidence that we may start reaching a saturation level in some European countries.

In the Primes baseline scenario, total travel of personal vehicles is projected to increase at 1.2% per year in 2000-2030 (it was 1.7% in 1990-2000). Both road and rail public transport continue to lose market shares.[18] According to this scenario, the slow down of the travel growth combined with the agreement between the European Commission and car manufacturers on a target for CO2 emissions per kilometre travelled (ACEA-KAMA-JAMA) will lead to an overall decrease of energy demand for private cars beyond 2010.

Freight road transport grew by 40% between 1990 and 2000 in the EU-15. The largest increases were observed in Spain and Greece (+69%), and Germany (+56%). Road transport activity per unit of GDP rose in all countries except in the UK and Portugal. The highest level of freight road traffic per unit of GDP is observed in the relatively poor countries, as Spain and Portugal in 2000. France and Germany still represent a large part of the trucks traffic in the EU, which is largely explained by the size of their territories, their location at the core of Europe, and their well developed road infrastructures.

*Figures 15 and 16: Freight transport in the EU*




Rail freight has lost market shares in all countries, and this situation should go on up to 2030, according to Primes scenario. In 2000, the market share of rail was 16% in France and in Germany, but only 7% in Spain and UK and 1% in Greece.

CO2 emissions from transport are growing rapidly in most European countries, reflected in an 18% increase at European level between 1990 and 2000. Per capita emissions of this sector totalled 2.5 tCO2. The strongest growth in emissions was observed in Spain (48%) and The Netherlands (34%).

In the Primes baseline scenario, the transport sector should become the primary source of $CO_2$ emissions in the EU-15 between 2005 and 2020, with power generation taking the lead thereafter.

[18] EU-15 Energy and Transport outlook to 2030, p61.

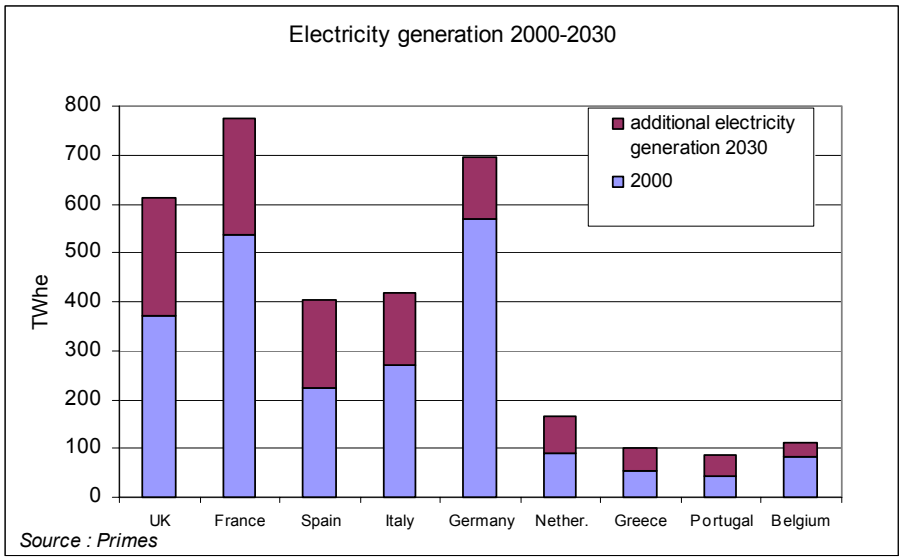
## II.D – Electricity

One third of Europe's energy-related CO2 emissions come from power generation. Although large transformations have taken place in some European countries' generation sector since 1990, the sector's emissions are expected to grow continuously in the near to medium term. Improvements in end-use efficiency have not been enough to offset the development of new end-uses, especially in the residential and service sectors.

### II.D.1. – Electricity demand

Per capita electricity production increased by 16% between 1990 and 2000. Considering existing policies, no inflection is expected by 2030 and electricity production per capita could increase by nearly 50% between 2000 and 2030.[19] In absolute terms, the largest power generation increases by 2030 are projected in the UK and France.

*Figure 17*

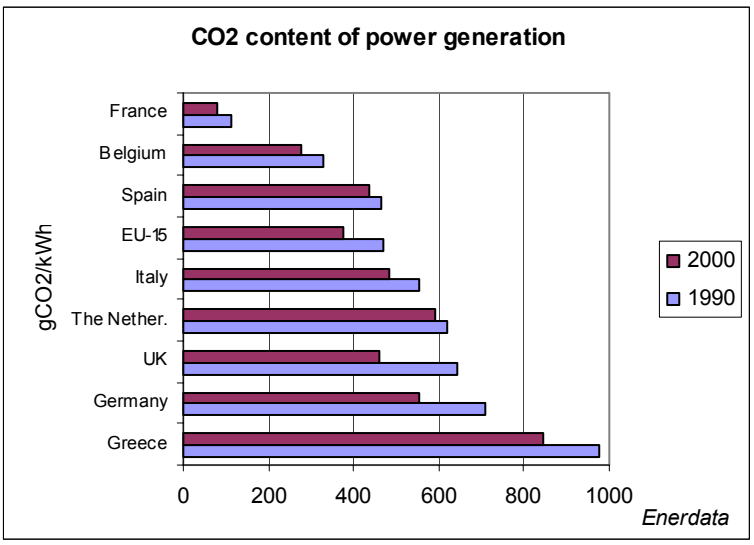



In the eight largest European countries, electricity consumption grew dramatically in all sectors, except in Germany's households sector (-6%) and UK's agriculture. The highest growth rates are recorded in the tertiary sector, then in the households sector (especially in Greece and Spain). As illustrated above, electricity consumption per household in the residential sector and per employee in the tertiary sector increases every year in all the European countries, except Germany. The share of industry in the total electricity consumption has been decreasing in favour of the tertiary sector. The share of the residential sector remains stable.

[19] European Commission – DG Energy and Transport, « European energy and transport trends to 2030", January 2003.

## II.D.2. – An on-going structural change in electricity supply

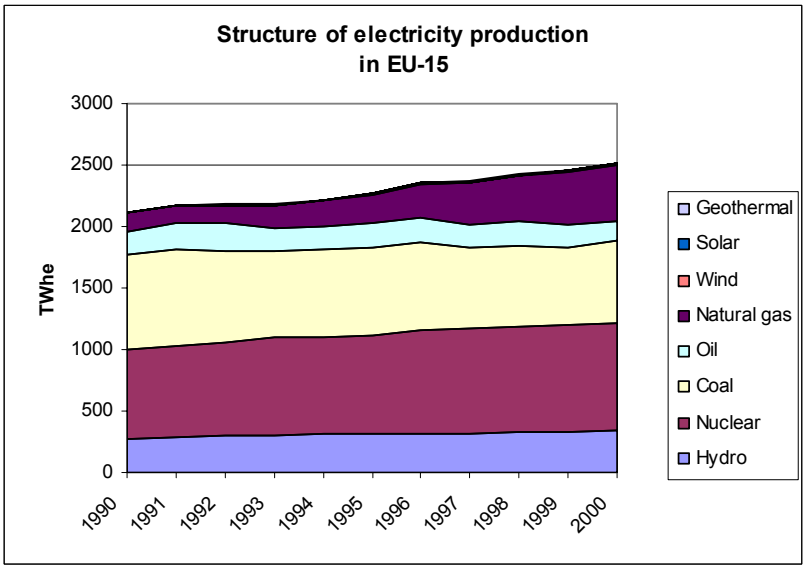
*Figure 18*




$CO_2$ emissions from power generation declined by 5% between 1990 and 2000, in spite of a 19% increase in total demand. This reduction is largely explained by coal to gas switching in the UK (46%), efficiency improvements in Germany's power supply, largely through the closure of older plants in the East (20%), an increase in non-fossil generation (nuclear and renewables, accounting for 34%)[20]. In 2000, Germany's power sector was the largest source of $CO_2$ in Europe (31%), followed by the UK (17%) and Italy (14%).

### II.D.2.1 – Fuel switching

*Figure 19*




Between 1990 and 2000, the share of natural gas in electricity production increased significantly, in order to match the growth of electricity demand. Coal's contribution declined by 10 percentage points in the EU in favour of natural gas, but it still accounts for 27% of total generation. The potential for further reductions through coal to gas switching remains important, as we will see later. At this stage, the contribution of renewable energy sources (except hydro) is marginal.

In addition to the UK, Belgium and Italy are also switching to gas, from coal and oil, respectively. On the opposite, electricity production from coal increased in two countries: +32% in Greece and in Spain. In 2000, Germany, the UK and Spain alone represent 73% of EU-15's coal consumption in power generation.

### II.D.2.2 – Growth and replacement of power capacity

Power capacity in the EU-15 was about 580 GWe in 2000. Assuming a 50% increase in electricity supply by 2030,[21] power capacity requirements must increase by some 370 GW. Some 510 GW of

[20] EEA, 2002a.
[21] EU-15 Energy and Transport outlook to 2030

new capacity will be required to replace older plants due for de-commissioning between now and 2030. In all, more than 90% of the installed capacity in 2030 does not exist yet.

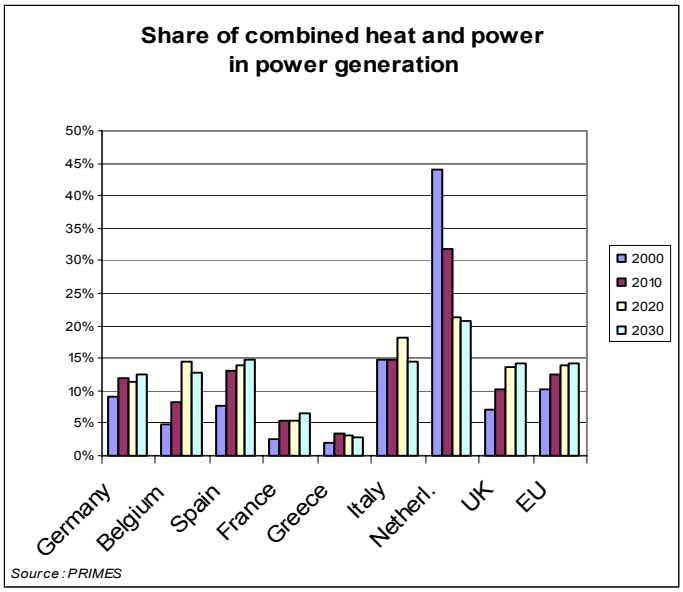
Based on current trends, most existing coal power plants should be closed in 2030. Replacing this capacity by gas would almost certainly induce an increase in natural gas prices but also questions about security supply. Both factors play in favour of coal-based technology. In the Primes baseline scenario, advanced coal technologies are introduced after 2015 and account for 12,5 % of the installed generation capacity by 2030 in EU.[22]

In 2001, emissions from coal power plants were 687 MtCO2 in the EU-15. This amount can be compared to 1 GtCO2 emissions of power generation and 3GtCO2 of the total emissions of the EU in 1990. Replacing all existing coal-based generation to natural gas would reduce emissions by some 320 $MtCO_2$ annually. In the Primes baseline scenario, coal power plants will generate 480 TWhe in 2010 and emit about 460 $MtCO_2$. It represents a 30% reduction in coal-based generation from 2000, and a savings of 100 $MtCO_2$. Substituting gas to half of the remaining coal generation would avoid an additional 160 $MtCO_2$, about 5% of the EU's total energy-related $CO_2$ emissions at present. However radical this structural change would be, it would not be enough to curb emissions significantly and cannot, therefore, be the sole element in the region's greenhouse gas abatement strategy.

### II.D.2.3 – Combined heat and power generation

The installed capacity of CHP was estimated at about 77 GWe in 2000 in the EU, or 22% of total EU thermal capacity[23]. The EU directive on cogeneration sets an objective of 18% of power generation from cogeneration. The Primes "baseline scenario" projects a less ambitious development, with a doubling of cogeneration capacity by 2030, reaching 146 GW.

*Figure 20*



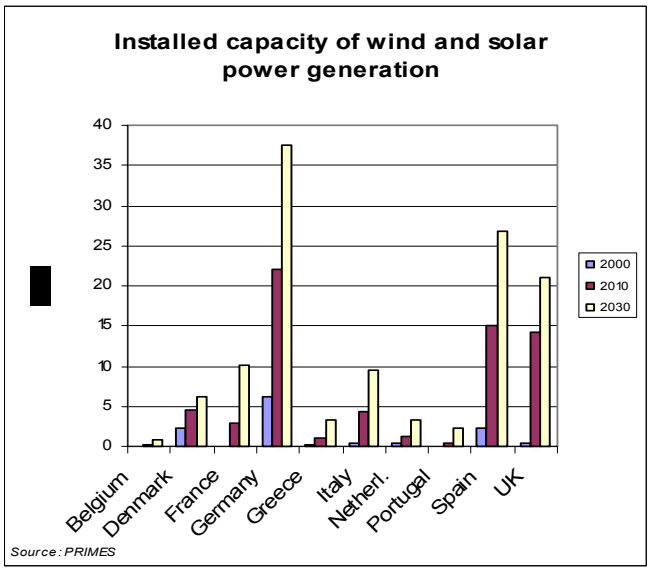

In the end, the share of CHP in power generation would only increase from 10% in 2000 to 14% in 2030. CHP's contribution would evolve differently from country to country, with rapid growth in a few countries (Belgium, Spain and the UK), and a large decreasing in the Netherlands. The projected increase in France would not be enough to bring this technology on the forefront of power supply by 2030.

[22] EU-15 Energy and Transport outlook to 2030, page 67.
[23] EU-15 Energy and Transport outlook to 2030, page 68.

### II.D.2.4 – Renewable energy sources

Electricity production from renewable sources including hydro and biomass grew by 2.8% per year between 1990 and 2000. The EU targets a doubling of renewables' share in total generation by 2010, i.e., 22% by 2010.

*Figure 21*




The installed capacity of wind is growing very rapidly (38.6% per year between 1990 and 2001). More than 4 GW of capacity were added between 2000 and 2001, with total capacity reaching 17 GW. Solar photovoltaics capacity is also growing rapidly, but from an extremely low level. Total capacity was only 284 MW in 2001[24]. The European directive's non-binding and ambitious objective should lead to 70 GW of renewable capacity by 2010. Primes projects 130 GW of renewable capacity in 2030, contributing to 18% of total electricity supply, a decrease from the projected 22% contribution in 2010, explained by the rapid growth in demand over the period.[25]

The total installed capacity of CHP, hydro, solar and wind was 180 GWe in 2000 (33% of the total generation capacity), according Primes baseline scenario, it will be 380 GW in 2030 or 40% of the total EU generation capacity.

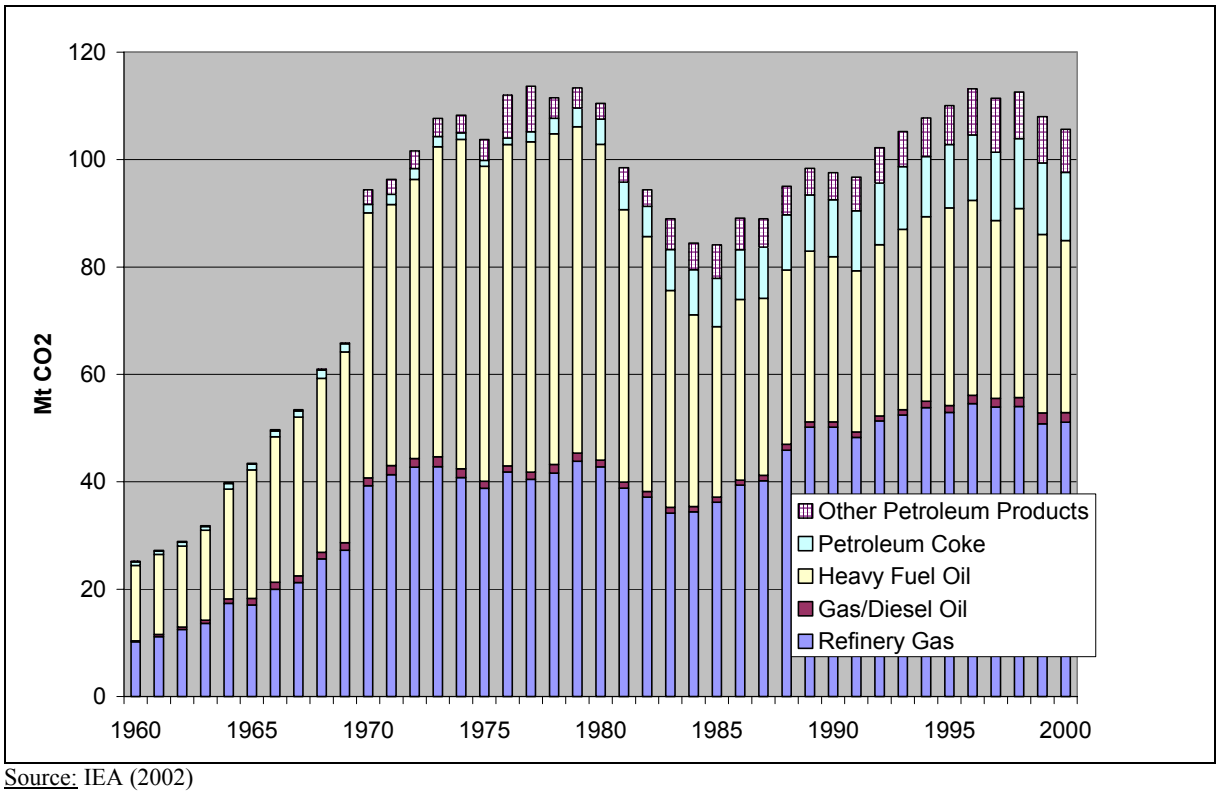
Some nuclear plants would be decommissioned over the same period. Despite an ambitious plan to develop CHP and renewables, the share of non-fossil fuel energy in power generation will slightly decrease between 2000 and 2030. This projection stresses the importance of energy efficiency policies to reduce emissions from the power sector.

[24] IEA (2003): *Renewables information*, IEA/OECD, Paris.
[25] EU-15 Energy and Transport outlook to 2030, appendix 2.

## II.E – Refining and other energy industries

Emissions from energy industries such as oil and gas extraction, including refining, are of course highly dependent on the global trends in energy supply and demand. Further, the perfect substitutability of refined products makes it quite straightforward to import these products from other regions when necessary or economically justified. Since $CO_2$ emissions are strongly correlated with the amount of fuel extracted and refined in the region, their trends as shown below are good indicators of the oil and gas market history.

*Figure 22:* **$CO_2$ emissions from oil and gas extraction and refining for EU-15 (1960-2000)**




Source: IEA (2002)

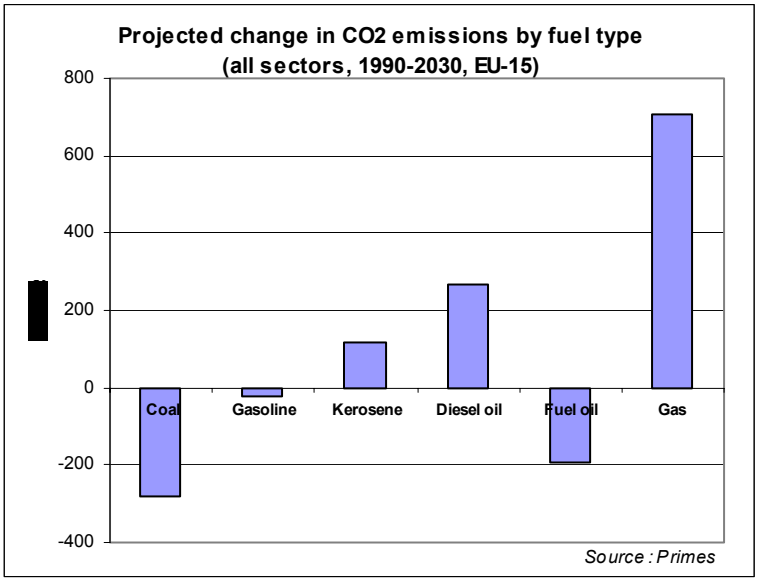
The very high energy consumption of extraction and refining activities has always encouraged energy savings. The refining industry achieved continuous energy efficiency improvements, measured in terms of energy consumed or $CO_2$ emitted per barrel of crude oil refined, in spite of an increase of the share of diesel and desulphurisation. In France, the industry has managed to stabilise the quantity of CO2 emitted per ton of crude oil throughput while delivering products to meet new environmental regulations for cars. However, the industry projects an increase in energy consumption in order to meet the European Auto Oil Programme standards for low sulphur fuels, to be implemented by 2005. Desulphurisation requires the use of hydrogen produced from natural gas reforming, with $CO_2$ emitted in the process.

## II.F – A few observations about sectoral emission trends

The figure 23 shows the stakes for the future policies in the European Union. The increase of CO2 emissions between 1990 and 2030 will be caused by:

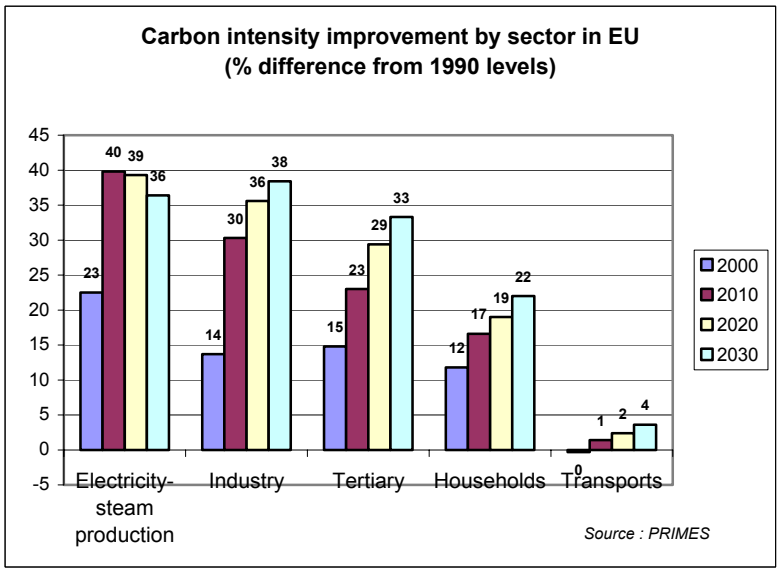
- a rapid growth in natural gas use, mostly in electricity supply, caused by an increase in electricity demand and further switching from coal and oil to gas,
- transportation growth : mainly freight transport and aviation travel.

*Figure 23*




These projections reinforce the importance of stronger policy intervention to curb electricity and transport demand. The Primes projections reveal that the potential for carbon intensity improvements in the EU is important up to 2010 in power generation and industry.

*Figure 24*




This potential would be exhausted beyond 2010 in the electricity sector, based on current policies. Industry is the only sector in which carbon intensity improvements would more than offset the growth in energy requirements.

The possibilities to lower the carbon content of transportation fuel seem limited, although a rapid penetration of hybrid technologies could somewhat change this outlook.

One interpretation of the above analysis of past and projected $CO_2$ emission trends is that three consecutive waves seem to be at play. The first wave has affected, for a host of reasons, the emissions

of the power generation and heavy industry sectors, where significant reductions have taken place as a result of the oil shocks, structural changes, and specific energy policy. Interestingly, the most ambitious policy interventions envisioned in the near future – the Directives on tradable $CO_2$ emission quotas, on renewable energy and co-generation – target these same sectors. Efforts to reduce energy consumptions, with some gains in $CO_2$ emissions as a result, have then taken place in the residential and buildings sector, but obstacles for further improvements remain: the large size and long lifecycle of the physical stock, the number of agents that need to be involved both on the demand side (householders, small businesses) and the supply side (suppliers of appliances, builders, etc.). Last, the transport sector seems largely unaffected by measures taken to date to reduce energy consumption. Efforts to reduce the carbon intensity of personal vehicle travel can only bring about noticeable changes later in this decade.

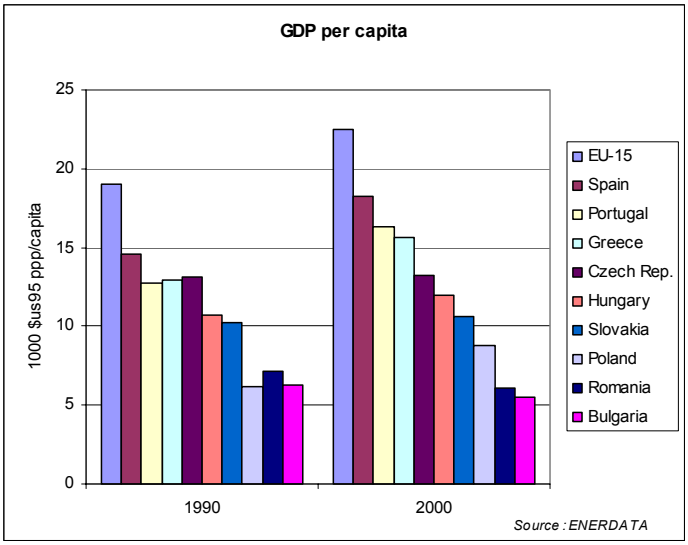
## III – European disparities: $CO_2$ emissions and the steps of EU expansion

On May 1, 2004, ten countries from the Central Europe will join the European Union. We present here some figures of the four largest accession countries, which represent 85% of the total population of the ten countries, but also of Bulgaria and Romania which should join the EU in 2007. How will the economic disparities evolve as these countries accede to the EU and what will be the consequences on the EU's CO2 emissions trends ?

In this respect, a presentation of the situation of the countries of southern Europe (Spain, Portugal and Greece) is useful as it indicates the energy development pattern of countries after their accession to the EU single market.

First of all, the three southern European countries have not yet caught up with the rest of the EU GDP per capital levels, and they are not likely to catch up in the near future. According to the European baseline scenario, existing disparities in per capita GDP are in fact expected to increase, both for southern and eastern European countries, compared with older member states.

*Figure 25*




## III.A – Spain, Portugal, Greece

The economic development of southern European countries appears fairly energy intensive in comparison with the rest of the EU. In 2000, the highest energy intensities in Europe were in Greece (0.19 koe/$95),[26] UK, Belgium and Portugal (0.18), then Spain (0.17). The average in EU was 0.14 koe/$95. Spain and Portugal are the only two countries with rising energy intensities in the EU between 1990 and 2000.Over the last thirty years, the energy intensity of GDP of these three countries grew while it decreased in all other European countries.

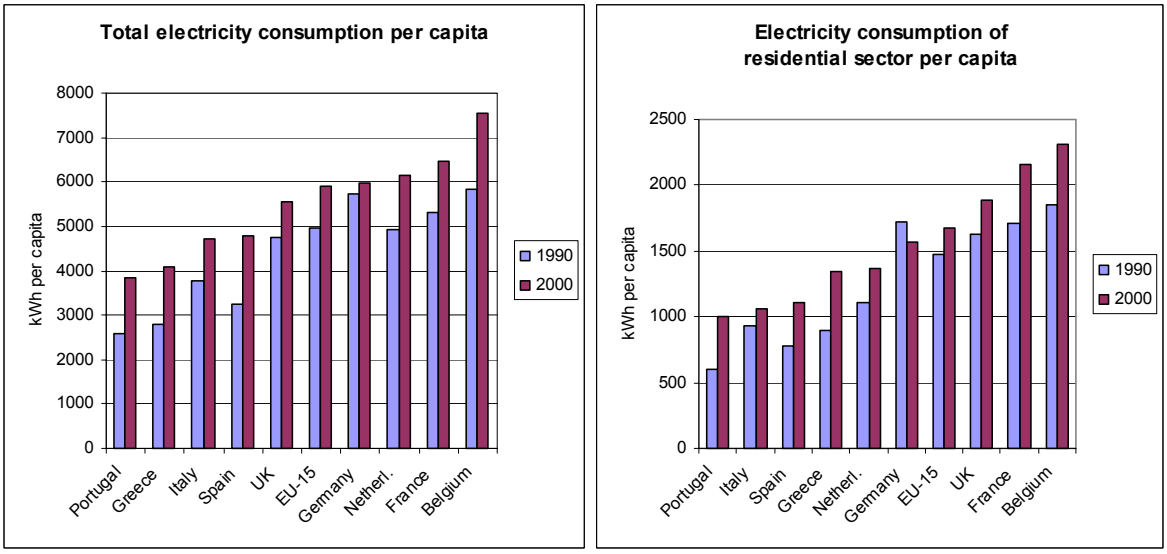
A structural reason for this difference is the lower share of services and households in the total final energy consumption, but these sectors are currently growing fast. Efficiency standards for new dwellings have been reinforced in 2001 in Greece (-30%/1979) and in 2002 (-7,5%/1988). Spain has not introduced a new standard since 1980.[27]

[26] ENERDATA
[27] Energy efficiency in the EU, Enerdata, 2003.

The share of the transport sector is also higher than the European average: more than 40% of the total final energy consumption of Spain and Greece (30% in the EU). Inside the transport sector, the market share of rail is very low; historically low investments in railway transport in southern Europe will remain a serious handicap for the implementation of $CO_2$ mitigation policies in this sector.

The industrial sector represents about 30% of the total final energy consumption, comparable with the rest of Europe, but the non-metallic minerals industry is relatively large (one third of the total industry energy consumption) with a low energy efficiency.

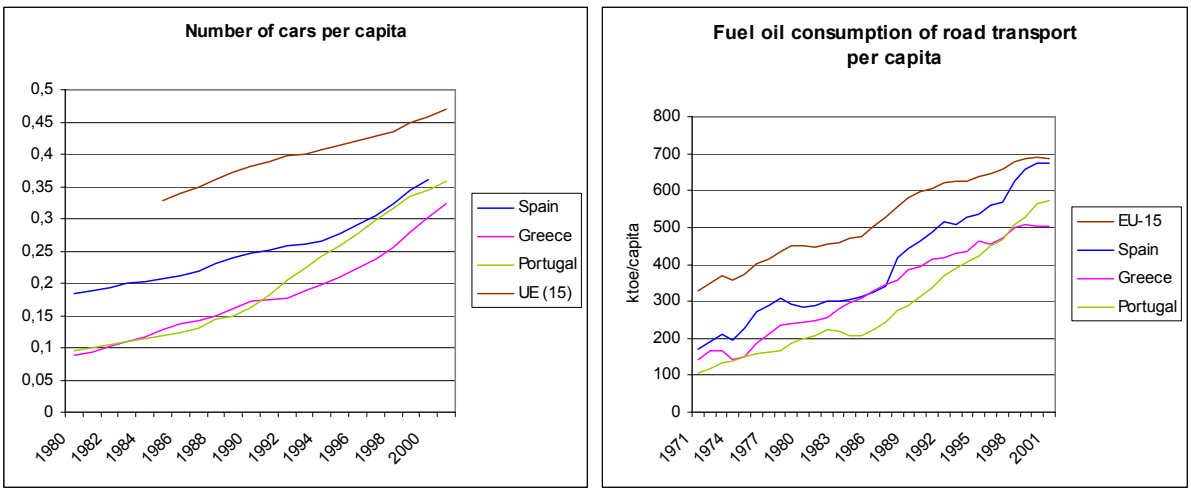
*Figures 26 and 27: Electricity consumption in Southern European countries*




*Source : ENERDATA*

Electricity consumption and transport grow rapidly in the three southern countries. Nevertheless, there is no sign of convergence inside the EU, mainly because there is no saturation in demand in these two sectors in the rest of Europe. We can only notice the high grow of fuel oil consumption in the road transport sector in Spain which nears the average consumption per capita of this sector in Europe in 2001.

*Figures 28 and 29*




*Source : ENERDATA*

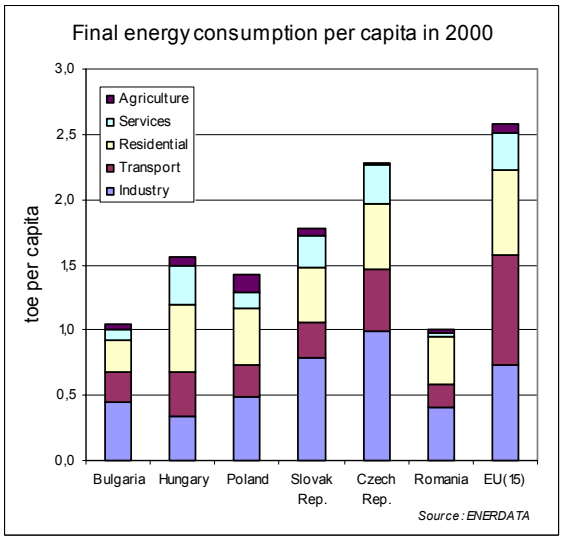
### III.B – Accession countries

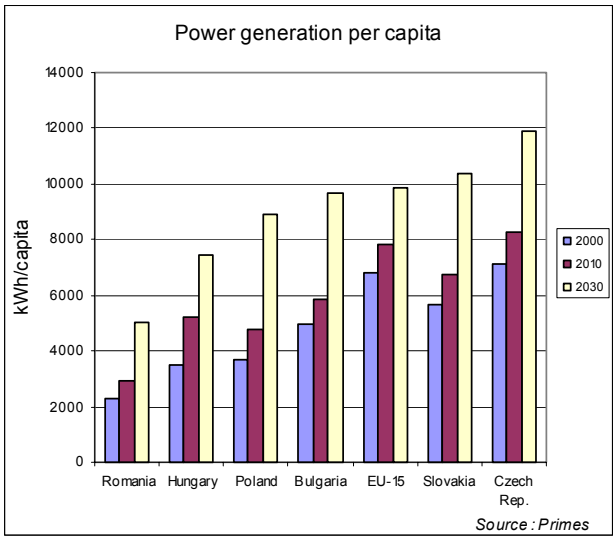
The population has been declining in the ten accession countries, which totalled 74 millions against 379 millions in EU-15. These countries account therefore for 16% of the total population and 12% of total energy consumption of EU-25. GDP per capita is growing, with an average around 10000 euros per capita, in purchasing power parity terms, in 2000 and an annual growth rate expected to be around 4% between 2000 and 2010.[28] Industry's contribution to GDP is usually higher in accession countries than it is in EU-15 (25% against 20%).

Final energy consumption per capita in the ten accession countries is lower than in EU-15 (respectively 1.6 and 2.6 toe per capita in 2000), and is projected to reach 2.4 toe by 2030, according to the Primes baseline scenario. The gap with the EU-15 would remain roughly the same as today.

The energy consumption per unit of GDP of accession countries has been decreasing since 1990 as a result of economic restructuring but remains high. In 2000, it ranged from 0.4 koe/euro00 in Hungary to 1.3 koe/euro00 in Bulgaria, against less than 0.2 koe/euro00 in EU-15.[29] In the baseline European scenario, primary energy demand is projected to grow by 26% between 2000 and 2030 in the acceding countries compared to 18% in the EU-15. These new Member states would account for about 12% of the EU-25 total final energy demand over the period.

*Figures 30 and 31*




The share of the industrial sector in final energy consumption is about 40% except in Hungary.

Industrial energy consumption is determined both by the industrial restructuring initiated in 1990 and the integration of these countries into the European industry. Accession countries' specialisation in heavy industry (iron and steel, chemicals) is inherited from the structural choices operated under COCOM, the USSR providing raw materials in exchange for finished products from central and eastern Europe. After the breakdown of the USSR, the lack of domestic resources and the obsolescence of productive capital contributed to the decline of these activities.[30] Poland and Slovakia have nevertheless stabilised their steel output since 1992. Foreign direct investment does not seem to modify the decline of heavy industry.

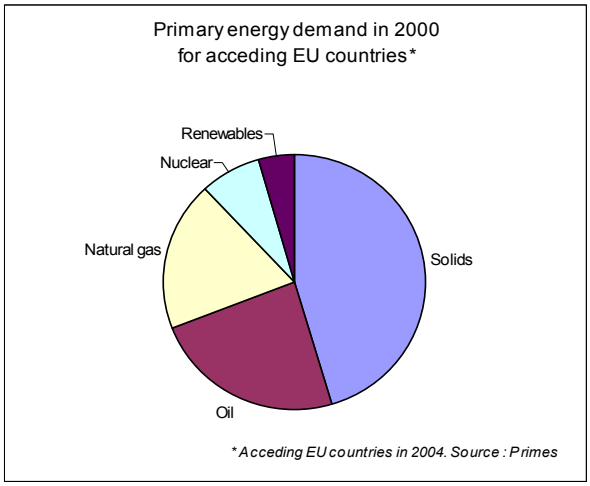
[28] EU-25 Energy and Transport outlook to 2030, p107.
[29] European Commission, « European energy and transport trends to 2030", January 2003.
[30] MINEFI-DREE, Les localisations industrielles dans l'Europe élargie, in Revue Elargissement, n°20, Mai 2002.

Labour-intensive activities (textile, wood) are slowly migrating to Romania and Bulgaria. Among fast growing industries are car manufacturing (Hungary), electrical products (Poland and Czech Republic), machinery and equipment, essentially intermediary products for exports.[31] If these industries are not among the most energy-intensive, increased trade of intermediary products could trigger a significant increase on emissions from freight through Europe. For now, the trade balance of these countries with Western Europe is negative, and is likely to remain so for some years given the rising internal demand for imported goods.

The share of transport in final energy consumption is lower than in the EU-15 but the situation is quite different between passenger and freight. The distance travelled per person is half the EU-15 level while the freight activity (ton-km) per unit of GDP is three times higher in acceding countries. Nevertheless, 43% of the freight activity is met by rail transport; this share is expected to decline to 24% in 2030 in the baseline European scenario, remaining much higher than in EU-15 (9%). As public transport and rail transport have large market shares, energy consumption in the transport sector, measured with per million of passenger-kilometre or million of ton-kilometre, is much lower than in EU-15. A 2030 projection of transportation needs in transition countries shows the possibility that its CO2 emissions increase by 70% from 2000 levels, reaching some 145 $MtCO_2$[32] – not including emissions from electricity demand in the rail sector.

Residential energy demand declined by 12.5% between 1990 and 2000. Energy consumption per capita is lower in the acceding countries than in the EU-15 (respectively 0.46 tep/capita and 0.65 tep/capita). Households' energy demand is expected to grow much faster in the acceding countries than in the rest of the EU (38% between 2000 and 2030, against 19% in EU-15). The main driver is the household size, projected to decrease rapidly, a phenomenon already observed during the last decade in the south of Europe.

*Figure 32*




Coal accounts for about 50% of primary energy consumption in the acceding countries and two thirds of electricity generation. In the baseline European scenario, the share of coal should decline to 30% of the primary energy demand in 2020 in favour of oil and gas. The total coal consumption is expected to be stable beyond 2015 at the level of 72 Mtoe per year for the ten acceding countries.

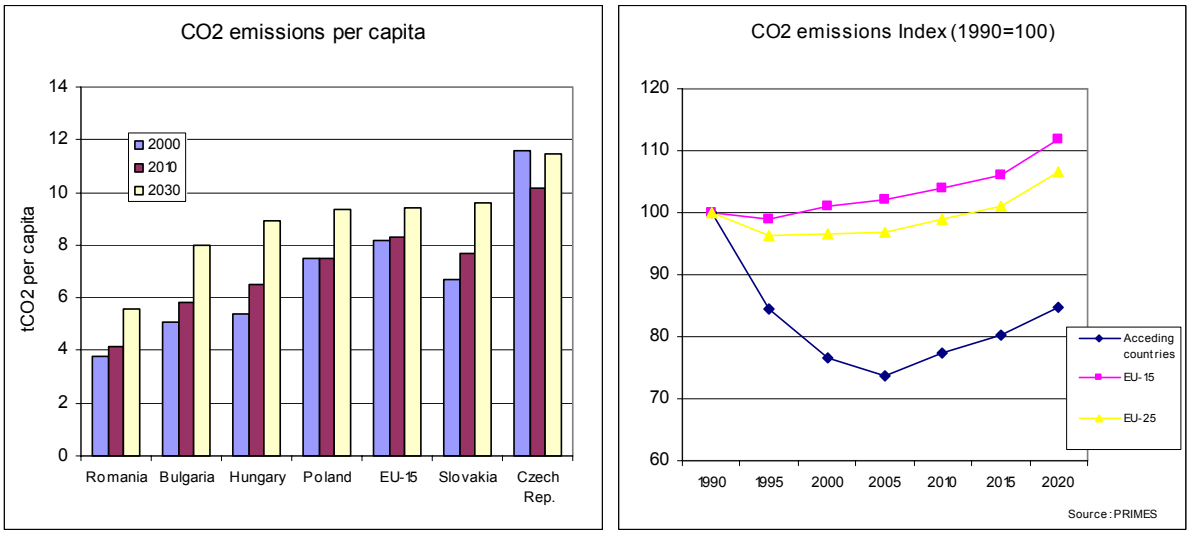
Despite low GDP levels, $CO_2$ emissions per capita are close to the EU-15 average. In the Czech Republic, the GDP per capita was one 60% of the EU level in 2000 (in PPP terms), yet its final energy consumption per capita was only 12% below and the CO2 emissions per capita were 11.6 tCO2 against 8.5 in EU-15, a situation that is largely explained by the fairly high reliance on domestic coal for power generation.

According to the baseline scenario of the European Union, $CO_2$ emissions of the 10 acceding countries will increase beyond 2005, after a sizeable reduction in the last decade. In all, $CO_2$ emissions in EU-25 will remain lower than their 1990 level until 2010-2012, but they should be higher hereafter, unless new mitigation measures are introduced.

[31] Michael Freudenberg, Françoise Lemoine, Les dix pays candidats et l'Union européenne : l'intégration en marche, in La lettre du CEPII, n°169, juin 1998.
[32] Zachariadis, Kouvaritakis (2003).

Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Romania, Slovakia and Slovenia have agreed to an 8% reduction from their base year[33] by 2010, while Hungary and Poland have committed to a 6% reduction. All countries are on track to meet their Kyoto target except Slovenia (+2.6% in 1990-2000).

*Figures 33 and 34*




[33] Countries with base years other than 1990 are Bulgaria (1988), Hungary (average 1985-87) and Poland (1988).

## IV. Looking back – A brief history of energy and $CO_2$ in main European countries

Energy-related $CO_2$ emissions in Europe have been characterised by sometimes dramatic reductions over the last three decades. The causes are well known, but it is useful to lay them out once again because they are an indication of what, in the past, has made such changes possible. The question that immediately follows is: are these changes replicable, foreseeable, and desirable?

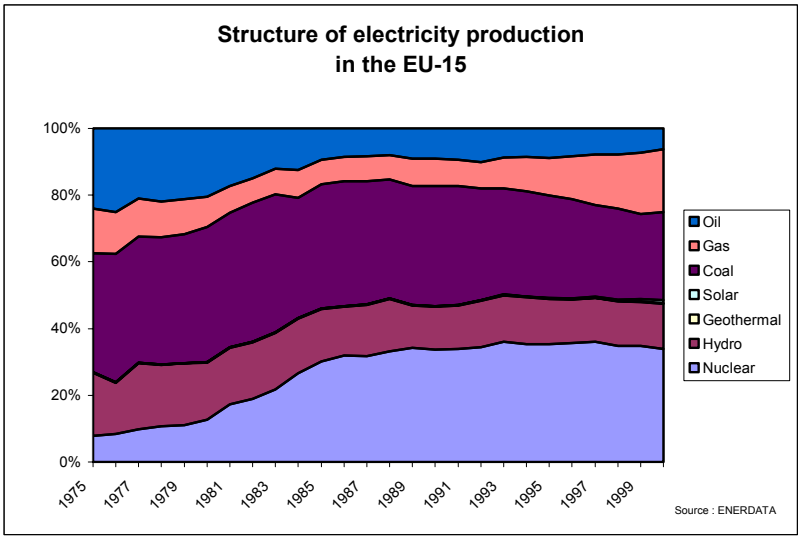
### IV.A – Geopolitical changes

The re-unification of Eastern and Western Germany is undoubtedly a major event in the history of Europe's emissions. Germany's emissions, which account for more than a quarter of Europe's total, have declined by about 20% since the peak in the mid-80s. The economic restructuring that followed re-unification, namely the closure of some of the most polluting plants in the East and the refurbishment of others are the main drivers of this downward trend. However, independent estimates find that re-unification is not the only cause of the country's emission reductions; it would amount to 50% of all GHG reductions between 1990 and 1995 and 60% of energy related $CO_2$ emissions. Energy efficiency policies and other structural changes are also at play in Germany.

### IV.B – Electricity: oil shocks, nuclear programmes, dash-for-gas and… renewables?

Electric utilities emissions peaked in 1973. Both as a percentage and in absolute terms, the use of oil for power generation seems to have been irremediably affected by the two oil shocks. The aggregate trend hides different substitution policies in response to this external constraint: Denmark chose coal and then gas and renewables, the Netherlands increased its coal use, Germany increased its reliance on coal. A number of European countries (France, Germany, the UK, Belgium, Sweden, Finland…), installed nuclear power capacity which now produces about one third of the region's electricity. Nuclear absorbed the lion's share of the observed increase in electricity demand since the 70s – total electricity output roughly doubled over the last three decades. In France, $CO_2$ emissions from power utilities decreased from 101 Mt to 32 Mt between 1973 and 2000.

*Figure 35*




The other major change in the carbon content of power generation is the United Kingdom's rapidly expanding gas-fuelled power generation capacity, mostly at the expense of coal – whose share decreased from 65% to about one third between 1990 and 1999, with a corresponding reduction in emissions of about 80 MtCO2 or 44%; emissions from natural gas use in power generation grew by 50 MtCO2 in the meantime. The fact that this rapid change in the profile of power generation was triggered by a reform of electricity markets in the UK can by no means be extrapolated to the

conclusion that market reform will have positive benefits on countries $CO_2$ emissions. The availability of significant natural gas resources in the UK and the low capital cost and lead-time for gas plants are the main explanation for this fuel's success. Market reform is clearly a double-edged sword for climate change goals, in the absence of specific GHG reduction measures. The UK power market reacted strongly to natural gas price increases, with a 24% increase in coal use between 1999 and 2001.[34]

Last but not least, energy efficiency measures were actively promoted as a response to countries' worrying energy dependency problems.

**IV.C – What other "breaks" in emission trends can we foresee?**

- Waiting for the next oil shock?

What sort of policy changes or events could trigger emission reductions at European level on a scale that is similar to what we have witnessed over the last three decades? Would an oil shock have an impact on oil consumption as strong as has been the case in the 70s? Several facts suggest otherwise: first, the oil crisis in 1973 was accompanied by, but not the cause of, a major economic slowdown that triggered further reductions in energy consumption. The convergence of these two phenomena was somewhat unique. Oil is now of lesser importance to European countries' economies than it has been in the past: it is only to the extent that oil would become rationed internationally that energy-related $CO_2$ emissions would be affected significantly.

Without envisioning rationing, a more permanent shift in oil prices at a higher level that experienced today would be followed by an increase in natural gas prices and would encourage the use of alternatives, including coal, nuclear and renewable energy. The overall effect on $CO_2$ emissions is therefore unclear, as far as generation is concerned – unless a $CO_2$ constraint on the sector's emissions is applied, as will be the case with the EU directive on $CO_2$ trading. Car manufacturers have, in the past, delivered new technology to improve the fuel economy of their vehicles – and are under some constant pressure to do so – but fuel amounts to a dwindling share of the total cost of mobility: it would take a very high crude oil price to trigger a major departure from current technological trends. In the end, policy intervention would be necessary to achieve this and would need to go beyond mere technology improvements and work on the structural determinants of mobility.

- New forms of policy interventions

Some of the policy instruments envisioned to implement climate change mitigation could have large-scale impacts on emissions. The emissions trading directive covers about 50% of the region's $CO_2$ emissions. A low $CO_2$ price and a liquid market could convince countries to bring the overall allocation down more rapidly than would otherwise be the case. At present, the distribution of effort is rather biased towards large industrial sources and the question is therefore whether more pressure on these would be acceptable in the broad climate policy picture. The mention of the transport sector's emissions in the trading directive is an indication that all sectors must take their share of the burden if ambitious goals are to become acceptable at EU level.

Renewable energy promotion is high on the agenda of European countries, but studies do not concur on how successful efforts will be and how much of an effect they will have on emissions in the next decade. The IEA projects 33 GW of installed wind by 2010[35] to be compared with 70 GW in the DG TREN projections – installed capacity totalled 17 GW in 2001[36]. With the latter projection combined with the growth in gas and a reduction in coal use, $CO_2$ emissions from power generation would remain stable until 2010; while the former projection results in a 10 percent increase (about 100 MtCO2): the development of renewables would not be enough to offset the rapid growth in gas-based

[34] IEA (2002), *The United Kingdom 2002 Review*, International Energy Agency, OECD, Paris.
[35] IEA (2002) – *The World Energy Outlook, 2002 Edition*. Paris, France
[36] IEA (2003) – *Renewables Information 2003*. IEA Statistics, Paris, France.

generation. A cap on the generators' emissions, as envisioned by the EC $CO_2$ trading directive, would of course affect both projections, although other industrial sources would be covered as well: in the end, the relative costs of mitigation should determine where reductions take place.

These two instruments fall again on sectors that have, in the past, delivered significant emission reductions in the EU (industry and power generation). The "pressure" that can be applied on parts of the economy will eventually depend on the overall fairness of climate policy, i.e., on whether the burden is evenly shared across sectors.

- A strong climate signal?

Last, repeated signals of climate disruption could help mobilise citizens and cause behavioural changes that would otherwise be difficult to achieve through policy instruments alone. This is obviously a "wild card" even if recurring climate related impacts have started to raise the awareness of the general public about this global environmental problem. The step from awareness to changes in energy consuming behaviours is by no means straightforward.

## V – Conclusion

If we were to ignore the facts about sector-level emission trends presented above and focus on the emission reduction objective set at Kyoto, we could easily conclude on Europe's ability to meet its objectives: a few percentage points could probably be obtained by "pushing harder" on a few policy objectives (slightly more renewables, more stringent caps in the EU ETS, a slight increase in gasoline prices, or an extra gram of CO2 per km in the ACEA voluntary agreement…) We would need to rely only marginally on the flexibility provided by the Kyoto mechanisms – notwithstanding an extensive use of Article 4 in the EU burden-sharing agreement.

Why is the EU so much closer to its Kyoto objectives than countries like Canada, the US, Japan or Australia? One could argue that the EU convinced other Parties to the negotiation to take much more ambitious targets through negotiation skills. Or that we owe our presently low emissions it to an unfortunately low GDP growth over the last decade. Or that we have implemented, since Kyoto, wide-ranging policies and measures to keep us on a declining emission path?

While some of these elements carry some validity, the previous section makes it very clear that the EU as a whole owes its currently low emission path to major, non-climate related, events and policy-decisions, and that these are rather country-specific and not reproducible. For instance, electricity market reform will not lead to the sizeable emission reductions witnessed in the UK over the 90s.[37] Transition to a market economy – and the accompanying closure of inefficient heavy industry plants, as has been the case in former East Germany, leading to much reduced emissions – is largely a phenomenon of the past in new EU Members.

We can portray the last decade of CO2 trends as the result of two categories of offsetting trends:

1. A decline in heavy industry's emissions (and electricity, as a whole), which compensated the increase in transport and residential emissions;
2. A reduction of major European countries emissions (Germany, the UK), that more than offset an increase in other countries' emissions.

Following are rather sobering messages regarding structural changes in GHG emitting sectors as we can see them at present.

- Energy demand in the residential building is increasing in spite of energy efficiency gains. There is a steady trend towards a decrease in average household size, leading to a rise in the number of dwellings. This has been observed in Northern Europe in the 80's, is underway in Southern countries and is likely to occur in acceding countries as their income rises. With the exception of Germany and, maybe, the United Kingdom, countries have yet to introduce retrofitting policies that *could* enable drastic reductions in final energy demand.

- The tertiary sector, arguably less energy-intensive than industrial activities, is nonetheless increasing its contribution to total energy demand and induced $CO_2$ emissions. In EU-15, the overall building space dedicated to tertiary activities increased by 32% in ten years. The tertiary sector accounts for a growing share of GDP in accession countries (71% in Poland, 67% in Hungary, 63% in the Czech Republic[38]): without a policy focus on energy efficiency improvements, the tertiary sector could contribute to a rise in demand for heat and electricity.

- The evolution of the transport sector represents the most significant climate policy challenge at two levels: First, projections concur on the result that transport is to contribute the lion's share in the emissions increase of the EU, in spite of the voluntary agreement to reduce the

[37] Which country in Europe is both relying heavily on subsidised coal for power generation and has abundant gas resources waiting to be tapped?
[38] Praussello (2003)

carbon content of travel for new vehicles in a few years. There does not appear to be a technological solution nearing implementation in the EU, of a magnitude that could offset the effect of increased traffic, and increased onboard equipment on $CO_2$ emissions. Trade flows to and from accession countries have grown faster than their GDP in the last decade[39]. Such trends should bring with them a rise in freight. Second, further efforts to mitigate emissions in other sectors will be difficult to accept if governments do not undertake meaningful efforts in the transport sector.

- Curbing power generation's emissions requires determined action to improve the efficiency of appliances, and to do so at a rate that outpaces the increasing demand for its services. Current policies, namely the Directive on $CO_2$ emission quotas, the Renewable Energy Directive and the Co-generation Directive are likely to affect the sector's contribution on the supply side. Demand might require more significant policy intervention than what has been done to date.

- Last, even sizeable potentials for energy efficiency improvements in new EU Member states cannot bring noticeable reductions at the level of EU-25, given their small share in total energy consumption and related emissions.

The above suggests there is ground for concern because the determinants of energy-related emissions are on the increase: rather than the direct observation of CO2 emissions, we ought to be concerned with the rising demand for energy services (heat, mobility, various uses of electricity). With the exception of some industrial sectors, demand for these services is on the rise throughout Europe, and more so in countries that are catching up economically with their more advanced partners.

The future of the EU climate mitigation strategy is, therefore, not about meeting Kyoto objectives through incremental progress in policies currently in place. It is about avoiding emissions turning out to be out-of-control, once all "one-off" reductions have petered out and sectors whose emissions are on the rise dominate the trend.

This represents a new, challenging, policy era for the EU, because it implies designing a set of policies that is truly motivated by both industrial and environmental goals, when $CO_2$ emissions had, so far, been by-products of other policy goals – and exogenous shocks. That said, it would be misleading to think that these new policies will have positive impacts solely on the global climate. In many instances, they could bring about health, social and economic improvements. Harnessing these other policy objectives to the task at hand can only help.

One potentially counterproductive reaction would be to encourage individual countries to look inward at their so-called national circumstances as so many barriers to progress – after all, we are easily led to think that buildings and transport energy choices are driven by local choices and conditions – and to focus solely on these domestic questions. Responding to climate change in a meaningful fashion requires massive transformations in physical capital stocks, new infrastructures going beyond national borders, and the participation of companies that have now acquired a European – or global – dimension (be they suppliers of building material, electric appliances, transport equipment etc.)

Policy solutions must be cross-cutting and in some cases European if they can meet the tall order of long-term climate policy objectives:

- International approaches are needed on sectors most subject to so-called leakage (e.g. international road freight measures);
- Climate-only policies are difficult if they stand alone, as is shown in the current discussion of national allocation plans of the EU ETS. A broader setting reflecting social and economic objectives is required, involving not one but the many different activities contributing to GHG accumulation. Asking industry (and the power sector) to bear most of the effort will soon have run its course otherwise.

[39] USAID (2002)

The following questions are in order if the EU is to succeed in its attempt to significantly curb GHG emissions in the medium run:

- What policy areas seem to require international coordination in order to allow effective and efficient GHG mitigation policies? What policy options are counter-productive if not led at EU level?

- Is there EU-wide consensus on where action is needed at this stage (e.g. international infrastructures to limit road transport)?

- Could existing EU regulations (agriculture, budget, energy, competition, etc.) stand in the way of effective climate mitigation policies undertaken by Member countries?

- Are additional market mechanisms necessary and suited to tackle rising emissions in activities other than those covered by the EU GHG emissions trading scheme?

- More broadly, how would the EU approach a new burden-sharing agreement, in light of current emissions trends in various EU countries?

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