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Climate Change and employment

Impact on employment in the European Union-25 of climate change and CO_2 emission reduction measures by 2030

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Partenaires du projet "Impact sur l'emploi du changement climatique et des mesures de réduction des émissions de CO_2 dans l'Union européenne à 25 à l'horizon 2030":

European Trade Union Confederation (ETUC), Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS), Social Development Agency (SDA), Syndex, Wuppertal Institute

Sophie Dupressoir

Ana Belen Sanchez, Patrick Nussbaumer, Jorge Riechmann

Pierre Bobe, Daniel Dubois, Christian Duchesne, Alain Mestre, Jules Monplet, Philippe Morvannou, Jean-François Poupard, Hélène Robert, Mourad Tagzout

Vera Höfele, Wolfgang Irrek, Lutz Jarczynski, Dagmar Koths, Magdolna Prantner, Frederic Rudolph, Carolin Schäfer-Sparenberg, Stefan Thomas, Oliver Wagner

With the collaboration of Sindnova

Matteo Auriemma, Giuseppe d'Ercole

Couverture : photos Ademe.

Summary

Introduction

The European union movement is convinced of the urgency of an ambitious European policy to fight climate change, in keeping with the sustainable development movement and rooted in a broad social consensus. The European Trade Union Confederation (ETUC) recently called for the European Union to adopt medium- and long-term targets to drastically reduce its greenhouse gas emissions, emphasising the positive opportunities, both economic and social, opened up by the transition to a low-carbon economy. A political consensus among the Member States seems to be emerging in favour of emissions-reduction targets in the range from 15% to 30% by 2020 and from 60% to 80% by 2050, compared with the level of 1990[1].

Meantime, it is certain that Europe will have to face a greater or lesser level of climate change, the magnitude of which is not currently known. The EU's climate policy is in keeping with the target of limiting the global temperature rise to 2°C in relation to its pre-industrial level. This level is considered sufficient to reduce the probability of irreversible and extremely damaging effects but will not suffice to avoid a change in the climatic conditions we currently experience. Moreover, the scenario of a temperature rise greater than 2°C cannot be excluded. The European Union represents only 14% of global emissions, and the essential commitment of the totality of emitting countries, both developed and emerging countries, is not guaranteed at this time by a global agreement.

For the European union movement, the success of the implementation of the Kyoto Protocol in Europe, and, beyond 2012, of more ambitious emissions-reduction policies, as well as of climate change adaptation policies, will depend in large measure on the ability to mobilise the key players, unions and business, to make full use of the potential of environmental policies to create quality jobs and to anticipate changes in jobs and skills which will result from them so as to ensure a fair distribution of the costs and opportunities among all economic sectors and with workers.

The overall net impact on employment of policies to counter climate change is estimated to be minor and slightly positive. However, we can expect major redistributive effects, taking account of the broad structural changes which will be required as well as the distortions of competition on the international scale as against countries which do not ration their emissions.

To our knowledge, the effects of global warming on employment have not yet been studied systematically. However, it is very probable that the phenomena induced – changes in temperatures and precipitation levels, rising sea levels and changes to the frequency of extreme climatic events – will have implications for economic activity and employment in Europe. The Commission is currently preparing a Green Book on adaptation to climate change.

The EU's sustainable-development strategy adopted in 2006 calls on workers' organisations to enter into urgent reflection with political leaders about the medium- and long-term policies required for sustainable development. The Commission has also insisted several times on the need to identify the winners and losers of the processes of change towards sustainable development. A cost-benefit analysis of the EU's strategies in the area of climate change, taking account of both environmental and competitive considerations, was requested by the European Council in March 2004.

[1] Conclusion of the Environmental Council and of the European Council of March 2005.

This study was intended to contribute to such a reflection by providing an analysis of the potential costs and benefits for employment of the policies and measures against climate change as well as of the manifestations of the consequences of climate change in Europe.

This report comprises two divisions. The first, entitled "Impact of climate change", attempts to determine the potential impact on employment in Europe of the consequences of climate change (Part 1). The second, entitled "Impact of CO_2 emission reduction measures", analyses the potential implications for employment of climate-change prevention policies in the EU with time-horizons of 2012 and 2030 (Parts 2 to 4).

The study was carried out between January 2006 and February 2007 by a consortium led by the European Trade Union Confederation and the Social Development Agency (SDA), which includes Syndex, the Wuppertal Institute and ISTAS, and which benefited from the collaboration of Sindnova.

The conclusions and recommendations of the study appear in four parts :

- Part 1 analyses the potential consequences for employment of climatic warming in Europe;
- Part 2 presents the objectives, the hypotheses and the methodology of the "impact of CO_2 emission reduction measures" division;
- Part 3 analyses the foreseeable effects of CO_2 emission reduction measures on employment in Europe;
- Part 4 offers general (or sector-wide) recommendations for measures and policies to promote positive effects and prevent negative effects.
- the concluding part discusses the uncertainties and identifies the questions deserving further investigation.

Part I

Impact of climate change in Europe

1. Introduction

This report forms part of a broader study. The project 'Employment and Climate Change in Europe' is composed of two main sections. The first section analyses the impacts on employment of measures aimed at reducing greenhouse gases emissions. The second section evaluates the effects of climate change itself on economic activity and employment. The latter section is the object of this report.

Climate change is often described as representing one of the major contemporary environmental challenges humankind is facing nowadays (Watkiss et al. 2005, Van Lieshout 2004, FoEE 2005). From an economic point of view, climate change represents the 'greatest and widest-ranging market-failure ever seen' (Stern 2006). The effects of climate change on society will be manifold. The altered climatic conditions will modify economic activity throughout Europe. Quite obviously, other factors will influence employment and economic activity, those factors being perhaps predominant. Nevertheless, changed climate conditions will have an impact and could either counteract or further enhance the effect of other drivers. It is the aim of this study to isolate the other driving forces in order to highlight the effect of climate change.

2. Methodology

This report focuses on different sectoral activities. Namely, agriculture/forestry/fisheries, tourism, finance/insurance, health, infrastructure, and energy. The information source for the analysis is twofold. First, an extensive literature review places this research in its contemporary context. It allows for an overview of the knowledge in the field and to get some insight about the different points of view. Various literatures, such as books, published refereed journal articles, and un-refereed electronic publications, serve to explore the past and current discussions triggered by the topic. The sources are various, such as universities and research centres, international organisations, governments, trade unions, private sector, and NGOs.

Very few documents directly relate the changing climate with its impact on employment. Therefore, tendencies in regards to employment must be drawn from studies evaluating the impact of climate change on sectoral economic activities. Most of the studies reviewed present a sectoral approach, although some evaluate the effects at a global scale on a cross-sectoral basis.

Secondly, the information is completed by a series of interviews with key stakeholders at European level, particularly in the sectors believed to be the most affected by climate change (agriculture/forestry/fisheries, tourism, and finance/insurance). The interviews collect perceptions about the threats those sectoral activities face or possible new opportunities in a changing climate. Public authorities, employers, trade unions, and environmental Non-Governmental Organisations (NGO) have been contacted for interviews. The list of those contacts is to be found in Annex A of this report. An interactive process allowed the interviewees to comment on a draft of this document. Hereby, the *Instituto Sindical de Trabajo, Ambiente y Salud* (ISTAS, Trade Union Institute of Labour, Environment and Health) and the project team wish to cordially thank all the interviewees for their contribution to this study, as well as the study partners and project Steering Committee members for their valuable inputs and comments.

This analysis focuses on assessing first-order economic activity and employment effects principally. Although knock-on and redistribution mechanisms over the entire economy are acknowledged, their detailed evaluation goes beyond the scope of this study. Under first-order effects are understood those that are directly influenced by climate change. For example, reduced precipitations could reduce agricultural productivity and thus related employment (first-order). This reduced productivity could in turn force prices of agricultural goods to increase and result in a loss of consumer welfare, an effect which could also have an impact on employment (second-order). The latter kind of impacts in not considered in detail here.

Two types of impacts can be distinguished. First, climate change affects the value of assets. That is, for example, sea level rise altering the value of coastal land. Secondly, climate change alters income and employment directly, through changes in productivity for instance. Both of those aspects are considered in the study.

The study geographically covers the European Union with a special, but not exclusive, focus on three particular regions: the Iberian Peninsula, Germany, and Scandinavia. This allows for a widespread coverage of the very diverse climatic, geographical, and socio-economic patterns present in Europe.

Adaptation measures will also have an impact on the economic activity and employment. They do not represent, however, the main focus of this study.

3. European Union's circumstances

The European institutional organisation is particular in the fact that the Member States, 25 at the time of writing, delegate sovereignty for certain matters to independent institutions which represent the interests of the Union as a whole and its citizens. The European Commission represents the executive body of the Union.

The population in the EU25 totalled 456.9 million in 2004[2]. Bulgaria and Romania, by joining the EU at the beginning of 2007, increases it to almost 500 million. The population of the respective European Union Member States varies considerably, ranging from 0.4 (Malta) to 82.4 million (Germany).

3.1. Economic activity[3]

The Gross Domestic Product (GDP) has gradually increased in the EU25 during the last 10 years at an average annual rate of 2.3%. The service sector constitutes almost half of the gross value added. Although agriculture and fisheries, industry and construction have all increased in absolute terms, their overall share has slightly declined. In 2002, the agricultural sector contributed 2.5% to the EU25's GDP, the construction sector 5.1%, industry (excluding construction) 23%, financial intermediation (real estate, renting and business activities) 20.8%,

[2] Data source: Eurostat.
[3] Data source : Eurostat.

other services (wholesale and retail trade, repair of motor vehicles and household goods, hotels and restaurants, transport, storage and communication) 22.4%, and public administration and defence (including social security, health and education) 20.8%.

3.2. Employment[4]

In 2004 in the EU25, out of the 377.5 million persons aged 15 years or more, 51% (192.5 million) were in employment. Of those persons employed, the vast majority (82%) had a full-time occupation. 38.4% were highly skilled non manual, 24.8 and 27.1% low skilled manual and skilled manual respectively, while 9.7% had elementary occupations.

During the same year, the agricultural sector occupied 5% of the active population in the EU25, while the industry and market services employed 27.9% and 37.2% respectively. The rest, 29.9%, accounted for non-market services. Those figures, however, mask very high disparities amongst European countries. Over a tenth of the population works in agriculture in Greece, Latvia, Lithuania, Poland, Portugal, and Hungary. The extreme is represented by Romania where almost a third of the active population is employed in the agricultural sector.

The average unemployment rate was 9.1% in the EU25 in 2004. It ranged from less than 5% in Denmark, the Republic of Ireland, Cyprus, the Netherlands, Austria, and the United Kingdom, to over 12% in Poland and Slovakia.

[4] Data source : Jouhette 2005 and Eurostat.

4. Past and future Climate in Europe

The European climate features important differences, with a maritime influence in the West and continental characteristics in the East, the Arctic in the North and the Mediterranean in the South. The North Atlantic Oscillation influence Europe's interannual climate variability. In Scandinavia, mild summers and cold winters prevail, although winters are relatively mild considering the latitude because of the warming influence of the Gulf Stream. In Central Europe, winters and summers are mild. Around the Mediterranean Sea, summers are hot and dry while winters are generally mild and rainy, with some exceptions like the Spanish plateau, where winters are relatively cold and dry.

4.1. Past climate

The surface air temperature in most of Europe has increased during the 20th century on average by about 0.95°C in annual mean values (EEA 2004). This implies that Europe is warming up faster than the World average (0.7°C). Northern and Central Europe seem to have got wetter, while little or negative change can be observed in terms of precipitations in southern and south-eastern Europe (Parry 2000, EEA 2004). Extreme climate events, such as droughts, heatwaves, and floods, have increased, while extreme cold events have decreased (EEA 2004).

The Earth climate varies naturally over time. The human-induced greenhouse effect, mainly due to the combustion of fossil fuels, is combined with the natural variability of the climate. There is now a near consensus in the scientific community for most of the warming observed over the last 50 years or so to be attributable to human activities (IPCC 2001a). Ecosystems and socio-economic systems will have to cope with the combination of both anthropogenic and natural climate change.

The magnitude of further anthropogenic forcing on the climate system depends on future socio-economic scenarios. Those scenarios are commonly based on the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES)[5].

4.2. Future climate

According to the findings of the ACACIA (A Concerted Action towards a comprehensive Climate Impacts and Adaptations assessment for the European Union) project (Parry 2000), a comprehensive research project on the effects of climate change in Europe involving several leading experts, the annual temperatures in Europe warm at a rate of between 0.1 and 0.4°C/decade[6]. The warming is expected to be the greatest over southern Europe (Spain, Italy, and Greece) and northeast Europe (Finland, western Russia), and least along the Atlantic coastline of the continent. As a consequence, winters currently arbitrarily classified as cold are expected to become much rarer in the next couple of decades and could have disappeared almost entirely by the 2080s. On the contrary, hot summers are believed to become much more frequent. Although not explicitly quantified in the ACACIA project, an increase of summer heatwaves throughout Europe in terms of both frequency and intensity is seen as very likely.

In terms of precipitation, the climate models reveal a widespread increase in annual precipitation over northern Europe (between +1 and +2%/decade), a rather small decrease across southern Europe, and small or ambiguous changes in central Europe. The study also forecasts a probable increase in the frequency of intense precipitation events, especially in winter, as well as an increase of summer drought risk in central and southern Europe, findings with are consistent with other research work (see Kundzewicz et al. 2006). With regard to sea-level rise, the change by the 2050s is estimated to range between +13 and +68cm, depending on the scenarios assumed[7].

Recent findings indicate, however, that the climatic changes and notably the warming could be much more important than previously expected. A greater warming increases significantly the threat for irreversible processes and non-linear, non-marginal changes. Indeed, it is believed that an increase of the global air surface temperature of over 2°C with respect to pre-industrial levels, which has been estimated as the threshold to so-called 'dangerous climate change', is likely to be exceeded in the later part of the century, and possibly as early as 2035 if no significant climate change mitigation measures are undertaken (Stern 2006).

As an illustration of non-marginal changes, climate change is currently triggering a destabilisation of land-based ice-sheets. A series of recent studies reveal a strongly non-linear melting of ice masses, a process that is occurring at a much faster rate than previously anticipated (Kerr 2006). The Greenland ice-sheet is melting more rapidly than a few years ago. Indeed, based on satellite measurements, Murray (2006) is able to demonstrate that the Greenland ice-sheet has been contributing to sea level rise at an accelerating rate over the past four years. Murray (2006) estimates the volume of fresh water flowing into the sea each year from the Greenland ice-sheet to as much as the equivalent to 250km^3. Paleoclimatic evidence reveals that the expected warming, by destabilising the Greenland ice-sheet and portions of the Antarctic ice-sheet, could trigger sea level to have raised by several meters by the year 2100 (Overpeck et al. 2006), figure that is by far exceeding what is commonly assumed in climate change impact studies.

[5] For more information on IPCC emission scenarios, see Nakicenovic et al. 2000, 'Special Report on Emissions Scenarios', http://www.grida.no/climate/ipcc/emission/, viewed 25 July 2006.

[6] The IPCC's Fourth Assessment Report, that is to be published at the beginning of 2007, is expected to announce an increase of the global temperature of between 2 and 4.5°C by 2100, with the most probable value being 3°C. It seems also most improbable that the warming will remain under 1.5°C, while values of over 4.5°C are not to be disregarded. (*El Pais*, 26 December 2006; *Sunday Telegraph*, 11 December 2006)

[7] The IPCC's Fourth Assessment Report is expected to announce a sea level rise of between 19 and 58cm (assuming no sudden loss of important ice-sheets in the poles). (*El Pais*, 26 December 2006; *Sunday Telegraph*, 11 December 2006)

5. Sectoral effects of Climate Change

This chapter presents the potential effects of climate change in different sectoral activities according to the information gathered from both the literature review and the interviews with selected stakeholders.

The potential effects of climate change are very diverse, and are likely to alter basic elements of life, such as food, water, health, use of land and the environment, and disproportionately more damaging with increased warming (Stern 2006). This section presents a non-exhaustive list of those. Also, their potential first-order socio-economic implications are portrayed in the European context.

5.1. Overall

A moderate increase (1°C) of the mean global surface temperature would lead to balanced positive and negative effects depending on the regions and activity, with a probable rather beneficial global economic outcome for the European Union as a whole (Tol 2002). Similarly, Roson (2003) finds that some industrial outputs increase while others decrease in the EU under the modest changes in climatic conditions, highlighting significant cross-sectoral redistribution effects. Recent findings tend to indicate, however, that scenarios of low and gradual changes become unlikely as the atmospheric greenhouse gases concentration keeps on increasing.

There seems to be a consensus forming (see Mendelsohn et al. 2000, Watkiss et al. 2005) in arguing that a global mean temperature increase of over 2°C would be detrimental to the vast majority of markets worldwide. Non-marketed goods and services are likely to be similarly altered by such a scenario. Moreover, risks of large-scale irreversible system disruptions, such as the Atlantic thermohaline circulation weakening, the reversal of the land carbon sink or the possible destabilisation of the Antarctic ice-sheet become significant above a 3°C temperature change (Watkiss et al. 2005).

A recent study (Hansen et al. 2006) suggests that the global temperature increase threshold to so-called 'dangerous anthropogenic interference to climate' could be lower than 2°C. Indeed, they suggest 1°C over the year 2000 levels as a critical point. This figure approximately corresponds with the EU objective of not exceeding a 2°C warming with respect to pre-industrial levels. Current trends indicate, however, that such threshold could be surpassed by 2050 or even earlier (EEA 2004, Stern 2006).

The Stern Review (Stern 2006) evaluates the effect of climate change as being significant from an economic point of view at global level. Indeed, it could represent the equivalent of an average reduction in global per capita consumption of at least 5% over the next two centuries. If a wider range of risks and impacts (non-market impacts, amplifying climate system feedbacks, unequal climate burden) is taken into account, the estimates of damage could rise to 20% of GDP or even more. These are effects on a scale similar to those associated with the World Wars and the Great Economic Depression of the first half of the 20th century (Stern 2006).

A controversial study undertaken by Link et al. (2004) estimates the economic impact of the thermohaline slow down or even complete collapse. The regions directly affected by an alteration of that particular marine current are the most potent in economic terms to date (USA, Canada, and western Europe). The authors reveal that such a scenario would not lead to an absolute cooling of annual mean temperature in western Europe but rather it would limit the warming due to climate change. The authors suggest therefore a collapse of the thermohaline circulation to reduce both market and non-market climate change damages and to be actually beneficial economically, while also underlining the many limitations of their approach. The assumption for gradual response contrasts with Clark et al. (2002), who demonstrate the link between the thermohaline circulation and abrupt climate change in the past.

Some studies reviewed, such as the one mentioned at the beginning of the previous paragraph, are based on straight cost-benefit economic evaluations which, by their very nature, capture only to a limited extent the implication of climate change. The results of such approaches have to be interpreted with care as they intrinsically imply reductionistic technical assumptions as well as subjective judgments. Climate change is an extremely complex process which is altering equally complex and inter-related natural and socio-economic systems. A modelisation of such widespread effects, spread over multiple decades, represents an extremely challenging exercise. Although normative economic analyses might be enlightening under certain conditions for smaller-case and shorter time-frame issues, some authors (Toman 2006 for example) question their representativness of intricate processes such as climate change. Impact assessments generally only evaluate a mean, gradual response to climate forcing, rarely those related to changes in variability and risk of non-linearities, and even more seldom do they consider abrupt changes (OECD 2006) and irreversibility. Also, by assuming strong comparability (Martinez-Alier et al. 1998), normative economic analyses allow for trade-offs between climate change and economic values and presume that such trade-offs are 'physically possible and socially acceptable' (Toman 2006) across both time and space. Nonetheless, it is acknowledged that those evaluations contribute to the debate on impacts of climate change, yet it is of utmost importance to understand their limitations and fundamental hypothesises.

The research project ExternE[8] attempts to quantify the external costs of electricity generation, and notably the burden of fossil fuel in regard to climate change, in some European countries based on contingent valuation techniques. Under externalities are understood the costs imposed on society and the environment that are not included in market prices. The results highlight the potentially very large impact of climate change, with those externalities representing many hundred million EUR per year in Spain and several billion in Germany, for example.

Regional distribution

Aggregated estimates mask local disparities. Although no region will be left unaffected, the effects of climate change are unlikely to be uniform across countries and regions (Stern 2006). While climate change will affect the developing world foremost, industrialised countries are far from being immune (Stern 2006). Mendelsohn et al. (2000) demonstrate that the damages to markets are expected to be greater in western Europe, the former USSR and Asia. They also argue that the climatic conditions before the warming represent an important factor of vulnerability. Climate-sensitive sectors have, according to those authors, a hill-shaped relationship with absolute temperature. Therefore, in theory, there is an optimal temperature at which welfare in a given sector is maximized. This implies that farmers in cooler regions could actually benefit from warming. On the other hand, for farmers in warm regions, a further increase of temperature is detrimental. In reality, the nature of the influence of temperature is perhaps more complex and involves other parameters such as market mechanisms or the availability of alternatives, to quote only a couple. Also, the warming might induce sudden shifts in regional weather patterns (Stern 2006).

Darwin et al. (1995) argue that climate change will lead to significant land use conversion, possibly raising additional social and environmental issues. Also, they underline the fact that some farming communities could be forced to abandon specific agricultural activities, climate change having altered their economic viability.

Vulnerability to climate change is not exclusively temperature-dependent and varies greatly across regions. The WISE (1999) project reveals that rainfall is expected to decline throughout the year in southern Europe. Paradoxically, intense events of rainfall are expected to increase in that region. Furthermore, the analysis shows that several months of summer drought in every year are to be

[8] For more information, see http://externe.jrc.es/, viewed 6 October 2006.

expected in most of the Mediterranean region and southern France. In some parts of southern/central Spain, droughts could occasionally persist throughout the year.

In Spain, the stability and sustainability of agricultural production strongly depends on precipitation. Climate change is believed to further exacerbate the issues related to water shortages in the sector. Also, tourism plays a crucial role in the Spanish economy. The sector employs more than 2 million people, representing about 12.5% of total employment in the country. Because of its strong dependence on other sectors, such as agriculture, industry and services, changes in the tourism sector have far-reaching consequences over the Spanish economy. Furthermore, additional conflicts with other sectors of activity over resources, for example water, could arise.

Both positive and negative impacts could result from moderate climate change in Germany. No significant changes are to be expected in the agricultural and forestry sectors at national level. Germany, and Central Europe in general, are sensitive to extreme weather events, especially floods (Kemfert 2004, BMU 2001). Beach resorts could benefit from global warming, while winter resorts could suffer from poor snow conditions.

Pashkevich (2004) foresees that climate change impacts in the arctic regions will be 'great and rapid'. The European North is characterised by its contrasting level of socio-economic development across the regions. As a considerable proportion of incomes is derived from climate-sensitive primary resource industries, such as agriculture, forestry, and fisheries, those populations are vulnerable. Furthermore, and due to the little economic diversification, employment alternatives can be scarce in those areas. At national level, some sectors could benefit from moderate global warming, like in Norway for instance. Where negative impacts could be experienced, the relatively high northern European countries' capacity of adaptation is usually assumed to enable adaptation at national level (O'Brien et al. 2006).

5.2. Agriculture, Forestry, Fisheries

Europe plays a predominant role in the world's production of food. Although the agricultural contribution to Europe's GDP represents only 2.6%, the sector employs about 5% of all workers. Agricultural, forestry and fisheries productions are very climate-sensitive. The agricultural productivity has continually increased in Europe during the last few decades mainly due to technological progress, climate change having played a marginal role so far. Nevertheless, climate change will alter the productivity of land. This in turn will result in a reallocation of resources and thus agricultural commodities price changes. Assuming the absence of abrupt impacts, the economy at large may not be directly threatened by such changes. Local socio-economic effects, however, could be considerable.

Agriculture

Agriculture is the sector for which, by far, the most attention has been paid with regard to the effects of climate change. The European agricultural sector could benefit from moderate warming (global average temperature increase of less than 2°C) in high-latitude countries (Mendelsohn et al. 2000, Watkiss et al. 2005, WISE 1999, Parry et al. 1999, Stern 2006) according to modelled estimates. Similarly, the European Environmental Agency (EEA 2004) expects a positive impact of climate change for most part of Europe, in for instance northern Spain, southern France, Italy, Greece, and Scandinavia, foreseeing an expansion of cultivated areas northwards. Nordhaus et al. (2000) demonstrate that agricultural activities in countries with initial cooler climates could benefit from global warming. This positive impact is due to three reasons mainly (Ministry of Sustainable Development 2005). First, the increased carbon dioxide concentration in the atmosphere could enhance plants' growth by favouring photosynthesis, although this fact is still subject to considerable debate as this assumption results from experiments and remains difficult to extrapolate to the field (Easterling et al. 2005). Indeed, recent research work (Long et al. 2006) demonstrated that the crop yield stimulation by rising CO_2 concentrations will be much lower than previously expected via model simulation. Those findings are very relevant since many global studies on the impact of climate change on agriculture assume significant crop growth enhancement due to increased carbon dioxide in the atmosphere, and they question the assumption that increased CO_2 levels will compensate the negative impacts of climate change. Furthermore, other limiting factors, such as the availability of water or nutrients, are likely to hinder the potentially positive effect on photosynthesis. Secondly, the growing season is lengthened due to the warming in certain regions. And thirdly, higher temperatures enhance the breakdown of dead organic matter and thus the release of nutrients, which is currently a major limitation to growth for some plants. Nevertheless, climate change will alter species differently. This effect could create imbalances in ecosystems, possibly threatening species less favoured by the changed climatic conditions.

In contrast, however, countries with a warmer climate will be disadvantaged. Water shortage issues could be amplified, especially in southern Portugal, southern Spain, and Ukraine (EEA 2004, Kundzewicz et al. 2006). A 2°C global temperature rise could lead to a 20% reduction of water availability for crop yields in southern Europe (Stern 2006). In general, the yields are expected to decrease in the Mediterranean area. The excess heat will tend to shorten the growing season at low latitudes (Parry et al. 1999). During the 2003 extreme heatwave for instance, yields in Europe decreased by up to 30%. Also, the 1999 drought generates losses of over 3'000 million EUR in Spain (EEA 2004). Extreme weather events will also be detrimental through a higher risk of heat stress during the flowering season, a higher risk of rainy days during the sowing dates, a higher rainfall intensity, and longer dry spells. These effects are expected to be greater over the southern Mediterranean and North Africa. Noteworthy to mention here is that in south-eastern Europe, approximately 40% of the population live in rural areas and are strongly dependent on agriculture (Olesen et al. 2002). Therefore, the impact on employment could be significant in those regions. Furthermore, the increased water consumption by crop will cause acute depletion of soil water.

The *Modelling the Impacts of Climate Extremes* project (MICE 2005) found that the increased temperature predicted under SRES scenarios A2 and B2, assuming different socio-economic development patterns, leads to an earlier onset of the main development stages and a reduction of the growth season length for both crop types considered, sunflower (typical summer Mediterranean crop) and wheat (typical winter Mediterranean crop). The greatest adverse impact observed is in summer crops, in the southern areas of the Mediterranean countries, under scenario A2. Nevertheless, other models indicate that potato yield is adversely affected by warm summer conditions also in both Germany and the UK (WISE 1999). Also, it has to be underlined that occasional excess heat could counteract the potential benefit of moderate warming. Indeed, as demonstrated by Ciais et al. (2005), the extreme climatic conditions experienced in 2003 drastically affected gross primary productivity (20% below the 1960-1990 average) in Europe, with summer crops being significantly more affected than winter crops.

In brief, climate change is likely to further accentuate the already existing trend of agriculture intensification in northern and western Europe, as well as the decline in the Mediterranean and south-eastern parts of Europe (Olesen et al. 2002). New opportunities might arise. Indeed, climate change could allow for new crop species and varieties to be cultivated in areas were climatic conditions were unsuitable so far (Jacob 2005). Unusual varieties, such as sunflowers or even vines, may encounter favourable conditions in northern regions. However, optimistic views on potential positive impact of climate change often assume a high capacity of adaptation. The degree of adaptation depends on many factors, such as available technology, market structure and organisation for instance. Also, it is often assumed that a substantial amount of land at higher latitudes becomes suitable for agricultural production. Nevertheless, transition costs and the movement of population that is required (Stern 2006) are often ignored or under-evaluated.

Quite obviously, an increase in the frequency and intensity of extreme weather events, such as heat waves, storms, floods, droughts, and hails, would adversely affect agricultural productivity. It is often argued that an increase in climate variability accompanying global changes would actually have a greater impact that the mean climate change alone (Easterling et al. 2005). It results, however, extremely difficult to distinguish between natural climate variability and additional variability due to climate change. Nevertheless, recent studies demonstrate non-linear regional relationships between climate extremes and annual mean temperatures over Europe. For example, there seems to be a clear positive relationship between drought length and annually average temperature (Good 2006).

As far as livestock is concerned, the impact of climate change is twofold: direct through the alteration of farm animals' physiology and indirect by changes in the food supply (Easterling et al. 2005). An increase of temperature above a certain point can adversely affect the digestion process as well as the pasture time (Ministerio de Medio Ambiente 2006). Darwin et al. (2005) note that, because of the decrease in feed conversion efficiency due to high temperature, animal weight grains and diary output would be reduced during the summer months in relatively warm areas. Similarly, Klinedinst et al. (1993) find a loss, relatively minor, of milk production in Europe due to global warming. On the other hand, in relatively cool areas, grazed livestock is expected to do better due to increased forage. Klinedinst et al. (1993) argue that economic losses due to a substantial conception rate decrease (up to 30%) in many locations, and particularly in southern Europe, caused by global warming might be greater than losses from milk production declines.

In general, the studies reviewed find that the economic impacts of climate change on agriculture are relatively small at global level and represent 1% of GDP or less (Bosello et al. 2005, Darwin et al. 1995, Easterling et al. 2005). There is no consensus on the sign of the effect, though, which strongly depends on the extent of the warming.

In the case of a high climate change impacts scenario (assuming a high vulnerability of the crop to climate change), Deke et al. (2001) found that the western Europe region could actually see its comparative advantage increased with respect to other world regions. This is explained by the fact that resources reallocation and the market reaction could be strong enough to overcome the negative impact on productivity. However, they also demonstrate that, due to the costs of adaptation, there is a decrease of output in the other sectors of activity, leading to an overall relative loss in welfare.

During the interviews, hotter summers, droughts and water shortages, together with extreme weather events such as storms and floods, were perceived as the most threatening potential effects of climate change for agriculture and forestry in Europe. As highlighted by one of the interviewees, however, not only do the effects of climate change in Europe matter for European agriculture, but also the impacts affecting other regions of the world. Indeed, due to the interconnection of markets, changes in climatic conditions outside Europe could modify international trade and thus directly affect European agricultural activities. For example, a major part of the soy beans used as feed for livestock comes from outside the EU25 (mainly the USA and Brazil) nowadays. Climate change in those regions could therefore significantly affect European agricultural activities and markets. In terms of employment, the impact of climate change is expected to have a relatively neutral effect, perceived as perhaps slightly negative at global level. The regions experiencing scarcity of water are likely to be the most vulnerable to climate change in terms of agricultural productivity, notably the Mediterranean regions in general and the Greek Islands, Sicily, some parts of Spain, and Portugal in particular. The effect of climate change on the crop mix is expected in the long-term, with for example a possible gradual substitution of maize by sorghum since the latter requires less water and is more heat-resistant. New employment opportunities will arise, notably in the emerging field of biofuels. The promotion of biofuels is not only perceived as a tool for the mitigation of climate change, but also as possibly having positive social impacts by enhancing rural development. As for measures of adaptation, one of the interviewees suggested the establishment of a 'solidarity fund' in order to deal with frequent, but relatively little damages due to climate-related events, since national and international institutions usually only cover major damages. And finally, information is seen as crucial in order for local actors to understand the potential stakes and thus elaborate appropriate adaptation measures.

Forestry

The relatively long time-lag of forestry has to be kept in mind when considering adaptation to new climatic conditions. The consequences might therefore be felt for a longer time than for other ecosystems with more rapid response, such as agriculture. Nevertheless, similar trends as for agricultural products can be expected. Hence, biomass production is expected to increase in general (Sohngen et al. 2001), but most especially in higher latitudes, in the case of moderate and gradual warming. However, changes in precipitations and climate extremes might impede the growth enhancement. Indeed, Schlyter et al. (2006) argue that extreme climate events, such as spring temperature backslashes and summer drought, are expected to increase in frequency and duration. Those impacts might negatively precondition trees to other challenges, such as new pests and diseases. Insect and fungal attacks could be enhanced by climate change (Ministry of Sustainable Development 2005, Garcia et al. 2005). Overall, the impacts on forestry are not expected to be significant (Nordhaus et al. 2000). Nevertheless, the economic consequences of climate change effects at local level could be considerable, notably due to the expected increased volumes of wind-thrown timber (Schlyter et al. 2006). Significant local alterations in terms of employment are to be anticipated due to the regional character of forestry production (Garcia et al. 2005).

The limit for deciduous trees will be pushed further north and to higher altitude (Lundmark et al. 2005). A faster growth may lead to a deterioration of the wood's quality. Also, an earlier start of growth in spring may increase the risk of frost damage. Although precipitations should increase in general, locally, and particularly in southern Sweden, growth may be hampered by the shortage of water (Ministry of Sustainable Development 2005).

Temperature increase combined with a precipitation decrease during the summer months boosts the risk of fires, which represents a major concern in Mediterranean areas especially. The relationship between climatic conditions and fire occurrence is well known. In summer, high temperature, low air humidity and fuel moisture represent favourable conditions for forest fires. The changing climate conditions could thus affect the frequency and magnitude of forest fires. According to Piñol et al. (1998), both the number of fires and their magnitude rose significantly between 1968 and 1994, despite an increase of fire suppression efforts, in the area located between Barcelona and Valencia on the Mediterranean coast. They empirically demonstrate the correlation between the risk of forest fire and climatic conditions. In Italy, the increase of rainfall during spring will enhance the growth of grass and other vegetation and thus boost fires occurring in summer (WISE 1999). Similarly, Moriondo et al. (2006) found a general increase in fire risk in the EU Mediterranean countries, with a possible very strong impact in regions where forest cover is high.

In contrast with some of the studies mentioned above, the interviewees generally expect the net balance of the climate change effects as resulting negatively in terms of plant growth. Interestingly, the potential fertilisation effect due to high atmospheric CO_2 concentration assumed by many studies reviewed does not convince sectoral stakeholders. They argue that the positive effect observed in experiments will be hindered by other limiting factors in the field. The possible outburst of atypical diseases is perceived as one of the major threats posed by climate change to forests. In terms of productivity, the positive effect of a longer growing season could be counteract by the fact that, because some tree species can only be harvested in winter, the lack of snow and frost may render those forests difficult to proceed. The changes in the length of seasons could in turn affect the ratio of seasonal and temporary employees. Also, after natural disasters, the work load to clear the wood suddenly rises significantly and for a short period of time. The change in tree species for commercial exploitation is believed to happen through deliberate spontaneous shifts which are unlikely to be economically detectable.

Fisheries

Water temperature and salt concentration, both aspects influenced by climate change, represent key factors in terms of fish survival, reproduction and growth (Rose 2005). A displacement of fish species is to be expected (see for example Drinkwater 2005). According to the Swedish's Ministry of Sustainable Development (2005), higher water temperature could have negative impacts on salmon and trout reproduction, while on the other hand the growth of warm-water species such as pike, perch and carp could be favoured. Engelhard et al. (2006) also find the reproduction of herring to be influenced by climatic conditions. The fishing industry in the Baltic Sea is seen as the most vulnerable to the changes. The Spanish Ministry of Environment (Ministerio de Medio Ambiente 2006) expects a decrease of productivity in Spanish waters. Changes will affect the majority of marine organisms, from planktons to algae and fishes. Similarly, both fish distribution and abundance off the Portuguese coast are believed to be affected by climate change in the future (Sousa Reis 2002). In the recent years, important changes in the development of phytoplankton and zooplanktons have been observed. There has been a move northward of zooplankton species in European waters of up to 1000km, as well as an increase in mild and warm water species in the North Sea (EEA 2004). In general, marine biodiversity is decreasing, with one of the driving force being changes in climatic conditions, impairing the ocean's capacity to provide food (Worm et al. 2006). The rising carbon dioxide levels in the atmosphere leads to Ocean acidification, effect that has major impacts on marine ecosystems and possible adverse consequences on fish stocks (Stern 2006). Also if, as some indices suggest, climate change alters the thermohaline circulation, it would have widespread, ungraspable consequences for marine life and hence fisheries.

Fisheries play a marginal role at macroeconomic level in Europe, with the exception of Iceland where marine fisheries are estimated to contribute to about 15% of the GDP directly from fish sales and between 35 and 40% of the GDP indirectly through dependent economic activities (Parry 2000). Some communities, like in Portugal for instance, have a strong tradition in the fisheries sector. In 2002/2003, about 421'000 persons were employed in the sector in the EU. The number of fishermen has decrease by 4-5% per year since 1996/1997 (Salz et al. 2006), but hardly because of climate change.

Although the impact on fisheries at global level might be low assuming moderate and gradual warming (Nordhaus et al. 2000), the socio-economic consequences at local level resulting from a geographical reallocation of fish stocks might be important (Mendelsohn et al. 2006). Indeed, some regions' dependence rate in terms of employment exceeds 2%. Those regions are principally located in the Mediterranean basin and on the Atlantic coast, in Greece (Ionia Nisia, Sterea Ellada, Voreio Aigaio, Notio Aigaio), Spain (Galicia, Ceuta), and Portugal (Algarve, Acores), but also in the North Sea (north-eastern Scotland)[9].

Very little attention, not to say none, has been paid to the impact of climate change on employment in the sector so far. In the recent report published by the European Commission on fisheries and employment, Salz et al. (2006) list the main problems the fishing industry is facing: increasing fuel costs, crew shortages, limitations on quota and fishing effort. There is no mention of climate change-related issues. This probably illustrates the fact that fisheries currently face short-term problems significantly more preoccupying, like the effect of chronic overfishing, than those posed by climate change.

[9] Data source: Salz et al. 2006.

The interview revealed other threats posed to fisheries by climate change not mentioned so far in this report. For instance, the potential acidification of oceans due the high atmospheric CO_2 concentrations could affect the planktonic activity and thus the marine food chain. Also, the melting of ice-caps modifies the salinity, which in turn can disturb the marine currents circulation and hence the distribution of fish. However, the magnitude of the effect on employment in the sector, as well as its sign (positive or negative) is perceived as extremely difficult to evaluate. Issues related to climate change have only become relevant to the industry recently, and they are still regarded as a rather long-term concern.

Nevertheless, there seems to be growing concerns from the fishery industry about the reductions in cod stocks in the North Sea, which has recently been blamed on climate change. Yet, the major challenge to the sector nowadays is still posed by the extreme pressure put on marine ecosystems due to the unsustainable character of current fishing practices. Nevertheless, the problems the industry is currently facing could very well be exacerbated by climate change. The productivity in general is expected to be negatively affected by an increase of climate variability. Furthermore, the infrastructure fisheries rely on is vulnerable to extreme weather-related events.

Table I.1: Potential effects of climate change on economic activity and employment in the agricultural, forestry, and fisheries sectors

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
Mid- and high latitude regions	Rising temperature, high atmospheric CO_2 concentration	Positive impact on agricultural productivity. *Positive impact on employment overall.*	Medium-high	The warming level must remain moderate. The increased in productivity could be hindered by other limiting factors (water, nutrients, etc). High uncertainty about the fertilisation effect due to high CO_2.
Southern Europe, Mediterranean region	Rising temperature, droughts	Negative impact on agricultural productivity. *Negative impact on employment at local level.*	Medium	
Southern Europe	Rising temperature	Negative impact on livestock productivity. *Negative impact on employment at local level.*	Low	Heat stress could cause physiological changes.
Mediterranean regions	Higher fire risk due to rising temperature, droughts	Negative impact on forestry productivity. *Negative impact on employment at local level.*	Medium	
General	Increase in frequency and intensity of extreme weather events	Negative impact on agricultural and forestry productivity. *Negative impact on employment.*	Medium-low	
Fisheries communities (Iceland, Baltic Sea, Spanish and Portuguese coast notably)	Changes in Sea surface temperature, wind regime, water runoff, ice melt, or marine currents	Negative impact on fisheries productivity. *Negative impact on employment, possibly significant at local level.*	Low	

Table I.2: Potential effects of climate change on economic activity and employment in the tourism sector

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
Nordic regions, eastern Europe	Rising temperature, changes in precipitations	Positive impact on tourism demand. *Positive impact on employment.*	Medium	
Mediterranean regions, coastal resorts	Rising temperature, changes in precipitations, sea level rise	Negative impact on tourism demand during summer. *Possible negative impact on employment during summer.*	Medium	
Mediterranean regions, coastal resorts	Rising temperature in summer	Negative impact on tourism demand in summer, but positive impact in spring and autumn. *Possible positive qualitative impact on employment in the sector with more stable conditions through longer contract periods.*	Medium-low	
Low altitude mountain resorts	Rising temperature, changes in precipitations	Negative impact on winter tourism activities. *Negative impact on seasonal employment.*	Medium-high	
High altitude mountain resorts	Rising temperature, changes in precipitations	Possible positive impact on snow-related activities. *Positive impact on seasonal employment.*	Medium	Benefiting from a redistribution effect due to the loss of attractiveness of low altitude resorts.

5.3. Tourism

Tourism represents one of the largest economic activities, generating receipts of 263 billion EUR in 2004 according to the World Tourism Organisation (WTO 2005), the equivalent of approximately Austria's or Sweden's entire GDP for the same year. Also, tourism is crucial to many local economies and employment. Not only does employment in hotels and restaurants represent an important share of the total in the EU25 (4%), but the sector also plays a vital role as job creator. Indeed, the yearly growth rate in the hostelry and restoration sector overcomes the average growth of the whole economy (Bovagnet 2005).

Among the different factors contributing to a region's attractiveness for tourism, such as natural and man-made resources, political stability, accessibility and relative prices of tourism services, the climate conditions represent one of the main drivers (Rehdanz et al. 2004, Bigano et al. 2005, Agnew et al. 2001). Very generally, cool destinations become more attractive as they get warmer, and warm countries become less attractive (Bigano et al. 2005, Viner et al. 1999). This is in line with Hamilton et al. (2005) findings which demonstrate that if a cool country gets warmer, it first attracts more tourism. However, if it gets too warm, the trend is reversed as it adversely affects tourism activities. City tourism, for example, seems to be sensitive to extremely hot weather, while such trend is less evident for beach activities. Nevertheless, Agnew et al. (2001) argue that there is an optimal temperature for summer coastal tourism. Also, those rather cooler countries seem to generate less international tourism due to climate change, whilst warm countries generate more. As summers get hotter in the Mediterranean region, Nordic countries will become more attractive as tourist destinations. There are indices suggesting that tourists from northern Europe prefer domestic to foreign beach holiday in hot years (WISE 1999). Other researchers argue that, due to the complicated relationship between climate and tourist demand, a net positive economic outcome from tourism in northern countries might not be straightforward (McEvoy et al. 2006).

The temperature increase could influence the distribution of holiday trips during the year, with a possible increase of trips outside the usual season. There are indices indicating that tourists tend to shorten their holiday, as well as decide upon a trip on an ever shorter notice. Day-trips and short breaks seem to be more climate-sensitive than main holidays as people tend not to change their plans for their main vacation. And if they do, they tend to either stay at home or holiday in their own country. In Spain, there is the fear that foreign tourists will prefer to holiday in their home-country during very hot summers. Also, there are indices suggesting that nationals favour trips to the northern coasts or inland (Ministerio de Medio Ambiente 2006), rather than to typical beach resorts. Sea level rise and erosion threaten tourism infrastructures (Viner et al. 1999), some resorts possibly having to be relocated. Furthermore, water scarcity could become an issue in some tourist destinations (Perry 2000), so much so that their economic viability could be threatened. In general, climate change is very likely to exacerbate conflicts with other users over resources, principally water and land.

Important changes are expected as well in the temporal distribution of the tourism demand in Spain for example. Indeed, due to the change in climatic conditions, the demand in mountain regions could increase in summer because of the excessive temperature on the coast. Also, the seaside tourism demand could be flattened, with less activity in summer and more in spring and autumn, in relative terms. Overall, the tourism demand in Spain is expected to lose some of its comparative advantages due to climate change (Ministerio de Medio Ambiente 2006).

The variation of tourist flows will affect regional economies, although the macroeconomic effects might be fairly neutral (Berrittella et al. 2006). The relocation effects may indeed be stronger than the actual overall variation. Several studies (Bigano et al. 2005, Berrittella et al. 2006, Perry 2001, Perry 2000) suggest that the Mediterranean basin will become less attractive to tourism in relative terms due to the rising temperature in summer, and for eastern Europe to be positively influenced by climate change in this regard.

The change in snow conditions will affect winter tourism. Not only will the snow cover be thinner in the future, but also the ski season will be shortened (Bigano et al. 2005). The greatest impact will occur at altitudes below 1500m. Indeed, studies (Elsasser et al. 2002, Koenig et al. 1997) suggest that the snowline will rise from 1200m of altitude to 1500m or even 1700m in certain cases. The attractiveness of the landscape might decrease as well. Alpine glaciers could disappear completely for instance. Surprisingly perhaps, a moderate increase in winter temperature would lead to an increase of tourism activity as well, milder winter temperature becoming pleasant for winter-sport tourism other than snow-related activities, such as walking and hiking, mountain biking, provided that adequate facilities are available at the resort (Flechsig et al. 2000). There could be a redistribution effect from little resorts at medium altitude to higher resorts, like glacier resorts (Elsasser et al. 2002, Koenig et al. 1997). The adverse effect on employment of such redistribution of the tourism demand could be worsened by the fact that ski resorts are principally located in rural areas where alternative employment is scarce, most especially in winter.

Overall, it is suggested that the increase in population and wealth will more than compensate the potentially adverse effects of climate change at global level (Bigano et al. 2005). Such consideration is valid only under a certain number of delicate assumptions. Such optimistic estimates are merely legitimate under moderate, gradual warming.

The stakes of the sector in regard to climate change contrast somewhat with the relatively little involvement of actors in the sector so far. Although climatic conditions are acknowledged as a determinant driver, the tourism industry seems not to integrate climate change issues as such in its strategic plans, a finding which is consistent with previous studies (Agnew et al. 2001), let alone to evaluate its impact on employment. Most of the research work found has been undertaken in the academic sphere with very little participation of the tourism sector's stakeholders. The interviews conducted in the framework of this study confirmed this fact. It has to be noted, however, that stakeholders in the tourism industry seem to gradually consider climate change issues as relevant, possibly threatening long-term investments. Climate is considered as being a primordial factor in the choice of a holiday destination, but the industry is often more preoccupied by shorter-term aspects, such as terrorism for instance. Tourism is renowned for being a volatile business and its industry is highly adaptable. This could explain why the effects of climate change, although considered as potentially damaging, are considered as rather long-term issues. Public awareness about climate change may trigger a higher demand for eco-tourism, with its corresponding positive effect in terms of employment in the branch. The hypothesis of tourism demand flattening over a longer period (less peak demand in summer but higher in spring and autumn) brought forward by several studies is perceived as probable but limited by the fact that school holidays remain a main constraint to flexibility for many tourists. In line with the findings of the abovementioned studies, coastal regions in the South of Europe are expected to lose comparative advantages, while inland destinations might gain some. The interviewees noted the current trends of increasing demand for city tourism and cultural events, as well as health-related holidays, which could be seen as an attractive alternative for regions adversely affected by the effects of climate change. The EU25 is currently losing market share, although only in relative terms, to new markets such as China and India for instance, climate change not being perceived as playing a major role in this regard to date.

The tendency for short-trip holidays and holidays in the home-country is acknowledged, and perceived as influenced by lifestyle changes rather than climate change, but put in balance with the fact that mobility is increasing and strongly dependent on the availability and affordability of airfares. In general, it is perceived that information and awareness raising campaigns at European, National and local level are of utmost importance in order to facilitate adaptation measures.

5.4. Finance-Insurance

Insurance, and the finance sector in general, play a major role from an economic and employment point of view nowadays in Europe. Insurance is even sometimes regarded as the world's largest industry (Mills 2005, Swiss Re 2005). According to the ACACIA report (Parry 2000), the insurance industry turnover represents about 600 billion EUR, its assets run into 4'000 billion EUR and the sector as a whole employs some 1 million staff.

The consequences the insurance and financial services industry is facing in relation to climate change, mainly through changing occurrence probabilities of extreme weather events, are substantial. Climate change is very likely to increase uncertainty in risk assessment and thus affect the functioning of the insurance market (Vellinga et al. 2001). Several studies (Kemfert 2004, WISE 1999, ABI 2005) claim that the number and intensity of extreme weather events, such as heatwaves, floods, and storms, have increased in recent years and are likely to increase further in the future. In Europe, 64% of catastrophic events between 1980 and 2003 are directly attributable to extreme climatic and meteorological conditions, such floods, storms, droughts, heatwaves, etc. It is also estimated that 79% of economic losses caused by catastrophic events are linked to climate. Such economic losses have increased significantly during the last couple of decades, going from less than 5'000 million to 11'000 million USD yearly. Four out of the five years with the most important economic losses are posterior to 1997 (EEA 2004). The heavy floods of August 2002 caused 80 deaths en 11 European countries, economic losses of more than 15'000 million EUR, severe road and railways traffic disruptions, affected about 100'000 hectares of agricultural land, flooded major cities (such as Prague or Dresden), damaged cultural heritage, and provoked numerous landslides (EEA 2003).

Not only will the impacts of climate change influence insurance claims, but also, since the sector holds and manages important assets, they will influence those long-term investments (Dlugolecki 2001). As damage to property may increase, the insurance sector will be affected. In certain cases, some properties may simply become uninsurable against certain types of risks. In addition, new losses will emerge from life and health branches due to injuries and mortalities from weather-related disasters on one side, but also from thermal stress (Mills 2005), or chronic pulmonary symptoms (Swiss Re 2005). Similarly, insurance services linked to transport activities could be affected. Extreme weather events can cause significant damage to ports and airports. Also, off-shore oil platforms are particularly vulnerable. The consequences of transport disruptions or business interruptions have important impacts on economic activity.

The European insurance industry seems particularly exposed to the increase of weather-related disasters because of the relatively high insurance density in most European countries. Worth mentioning is the fact that not only are the effects of climate change in Europe relevant to the European insurance industry, but weather-related events in other world regions will also affect European insurers, and this in at least three ways. First, European insurers often provide financial services to European clients as well for their activities outside Europe. Secondly, European insurance companies, as global market key players, are also independently active in non-European regions. And thirdly, through reinsurance, many disasters striking regions far from Europe still affect the European insurance industry.

There seems to be a non-linear relationship between some climatic parameters and damages. Indeed, the damages caused by windstorms increase at a more than proportionate rate compared to wind-speed. They typically scale as the cube of wind-speed or more (Stern 2006). The costs of weather-related events rose by a factor of 15 during the last three decades (Kemfert 2004). The insurance industry expects a similar trend in the future and foresees an increase of the damage costs by a factor of 10 until 2050.

Noteworthy to mention here is that the increase in claimed damages might not be an adequate proxy for the estimation of the impact of extreme weather events as it does not only include the increase in frequency and intensity of such events, but also the increase in wealth and vulnerability (more building in coastal areas, floodplains, etc) and the increase in insurance penetration. It therefore results difficult to evaluate the proportion attributable to the effects of climate change (Piserra et al. 2005).

Side-effects of extreme weather events are rarely taken into consideration in analyses. For example, the impact on the tourism activity of a region affected by extreme weather can be substantial, although difficult to evaluate. Also, business interruptions due to infrastructure disruptions have serious economic consequences. Furthermore, only a minor part of the damages is insured in most cases, leaving most of the cost burden to be borne by other agents, individuals, businesses, or governments, depending on the extent of state intervention (CEA 2006).

In contrast, there seems to be very few direct or indirect positive impacts on the European insurance industry due to climate change in terms of damage claims. A reduced frequency of frost situations might slightly decrease the number of claims for instance. Compared with the negative impacts, however, the positive impacts appear to be marginal (Parry 2000).

Other authors (Mills 2005) have a slightly more optimistic view for the sector, arguing that insurers could benefit from opportunities due to climate change, by being able to offer new risk management products, and could actually experience an increase in the demand for insurance itself, with its potentially positive impact on employment in the sector. On the other hand though, insurers may have to withdraw from some activities where the risk is evaluated as being too high with changed climatic conditions.

Table I.3: Potential effects of climate change on economic activity and employment in the finance/insurance sector

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
General	Increase in frequency and intensity of extreme weather events	Economic pressure, especially on small businesses. *Negative impact on employment.*	Medium	
General	Increase in frequency and intensity of extreme weather events	Devaluation of assets owned by actors in the sector. *Negative impact on employment.*	Medium	
General	Increase in frequency and intensity of extreme weather events	Additional demand for experts in risk assessment, damage evaluation, awareness campaign, etc. *Positive impact on employment for specific professions.*	Medium	

Historically, the insurance industry has demonstrated its capacity to cope with many challenges, adapting premium prices, changing contractual terms such as deductibles or setting liability caps, as well as spreading the risk through reinsurance. The probable transfer of the additional costs, seen by Mills (2005) as a form of 'externalities of climate change', onto society by the insurance industry will have negative economic impacts, which in turn could negatively affect employment in general. The rapidly increasing costs of weather-related events put significant strain on the industry's profitability (Parry 2000). Substantial capital and reserves are required to face multiple incidents. The overall solvency of the European insurance industry is not believed to be threatened by climate change. Yet, important structural changes, with small regional businesses being particularly susceptible, are to be expected (Swiss Re 2005). Indeed, moves towards an increase in the size of the companies, a greater diversification, and an integration with other finance activities, in order to mitigate the potential risk of the so-called 'low probability – high impacts' events, are anticipated (EEA 2004).

The issue of climate change is taken very seriously by sectoral actors, with a great deal of involvement in research for instance, illustrating the magnitude of the industry's stakes in regard to this matter. However, none of the studies evaluate the impact on employment directly. For several years climate change issues have been introduced as a parameter to companies' strategic plans in the sector, and their relative importance is currently intensifying. The interviewees recognise the possible positive influence of the climate change effects on the sectoral employment through a potential increase in demand for insurance products and services. Yet this influence is difficult to quantify because of, amongst other factors, structural changes companies are currently undertaking which could lead to mergence between companies in the sector. There could be an additional need for specific types of professional knowledge, such as experts in risk assessment and scenarios development, damages evaluation after disasters, or advisors in risk prevention. Also, awareness and information campaigns might have to be developed in the insurance sector so as to inform the public and the authorities about climate change issues and the prevention potential in particular. According to the interviewees' perception, the need for such services should increase considerably. Similarly as for the agricultural sector, a solidarity fund was suggested during the interviews in order to alleviate the costs of non-insured damages after natural disasters.

5.5. Health

There seems to be a consensus in the literature arguing that climate change is likely to increase heat-related health issues and decrease cold-related ones in Europe. As heat waves are projected to increase in terms of both frequency and duration, mortality due to heat stress will increase accordingly. For instance, the extreme heatwave striking Europe, and especially France, in 2003 is believed to have caused a mortality excess of 30'000 deaths (McMichael 2006). In contrast, milder temperatures in winter will reduce the excess deaths, with particular benefits for northern countries (Watkiss et al. 2005). Many studies (Tol 2002, EC 2006, WHO 2003, Stern 2006) argue that the reduction in cold-related deaths will surpass the increase in heat-related deaths in Europe. There is an optimum temperature at which the death rate is the lowest. Outside the comfort zone (U-shape curve), mortality rises (McMichael 2006, Díaz Jiménez et al. 2005). Interestingly, it appears that the 'warm' side of the curve is steeper than the 'cold' side, implying that heat-related deaths in summer are more temperature-sensitive than cold-related ones. It has to be noted as well that the excess deaths seems to be correlated to socio-economic factors (Díaz Jiménez et al. 2005).

Extreme weather-related events, such as floods and storms, are expected to become more frequent with climate change (WHO 2003), representing an additional threat to life and health. Beside the physical impacts, the psychological consequences of such devastating events are not to be underestimated. Floods, for example, have acute adverse physical and psychological consequences on human health. Severe floods in 2002 in Austria, the Czech Republic, Germany, Hungary and the Russian Federation, caused more than 100 casualties. The increase in precipitations is believed to make floods in Europe more frequent. Nonetheless, fatal casualties per flood event seem to decrease significantly, potentially due to improved warning and rescue measures.

Furthermore, the heatwaves will become more dangerous in cities since urban environments tend to retain heat (Stern 2006).

The propagation of malaria is defined and limited mainly by the climatic tolerance of the mosquito. Climate change could alter the conditions that support the transmission of malaria and its latitude and altitude restrictions, as well as increase the time during which malaria may circulate. Therefore, a change in climatic conditions could increase the risk of localised outbreak in areas where the disease is eradicated but the vectors are still present. The original endemicity of the European countries is classified as 'low' or 'malaria free' by Van Lieshout et al. (2004). This implies that in many European countries, malaria transmission doesn't occur or only sporadically after importation.

Human intervention through strong health systems and effective malaria control, together with climatic preconditions, should allow for European countries to cope with a potential slight increase of malaria. The authors therefore conclude that there is no significant modification of risk for malaria outbreaks in the EU25 countries due to climate change. Likewise, another study (Swiss Re 2005) concludes that Europe should be relatively unaffected because of its privileged socio-economic conditions.

An increase in tick-borne diseases has been observed in the Baltic region and central Europe in the last couple of decades in response to the succession of warmer winters. Yet, the role climate change plays in this occurrence is still debated within the scientific community. Overall, the influence of climate change on vector-borne diseases appears to be negligible in Europe (Tol 2002, Kemfert 2002).

Global warming is likely to increase the occurrence of food-related diseases, such as salmonella, due to the enhanced microbiological activity (WISE 1999, McMichael 2006). Indeed, many infectious agents are sensitive to climatic conditions. A strong linear association has been observed between temperature and notification of salmonella cases in European countries for instance (McMichael 2006). Climate change could modify the ecological balance in regions where the conditions are currently unfavourable.

Table I.4: Potential effects of climate change on economic activity and employment in the health sector

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
General, northern countries especially	Rising temperature	Overall decrease in mortality and morbidity. *Negative impact on employment in health sector due to decreased demand for health services.*	Medium	
General, northern countries especially	Rising temperature	Decrease in mortality and morbidity. *Positive impact on employment through increased in labour productivity.*	Medium-low	Economy-wide
General, southern Europe especially	Extreme weather	Negative impact on labour's productivity for activities carried out outdoor. *Negative impact on workers health and safety.*	Medium	Economy-wide

The overall impacts of a moderate warming on health represent 0.02% of GDP for European OECD and eastern Europe countries, according to the estimates of Nordhaus et al. (2000). They also found that the impacts of climate change on health are highly temperature dependent, rising sharply after reaching a certain threshold. The particular interest of that study resides in the fact that it includes non-market aspects, which are evaluated based on the Willingness-To-Pay approach. A regional dynamic integrated model of climate and the economy is used in order to estimate the impact on different activities, based on 2.5°C benchmark warming.

Bosello et al. (2006) reveal with an economic general equilibrium model that climate change could positively influence the economic balance in Europe. Indeed, they demonstrate a net decrease of both mortality and morbidity due to climate change, although an increase due to respiratory diseases and diarrhoea is observed in Europe. This results in an increase in labour productivity and a decrease in the demand for health care. Their analysis is based on a rather conservative climate scenario, implying minimal temperature changes. Importantly, they also highlight the fact that the economy will tend to shift away from those countries and sectors that are negatively affected by climate change, an effect that could help mitigate the global vulnerability to climate change on the one hand, but amplify regional and sectoral impacts on the other.

Certain population groups are particularly vulnerable to disease and injuries. Young, old and frail persons are the most susceptible. The vulnerability of a population is also believed to depend on population density, level of economic development, food availability, income level and distribution, local environmental conditions, pre-existing health status, and the quality of public health care (WHO 2003).

Outdoor working conditions could be worsened in summer. An increase in temperature enhances the risk of heatstroke. During the 2006 summer in Spain, several deaths of outdoor workers due to heatstroke have been reported. Also, other types of extreme weather notably decreases labour's productivity for activities carried out outside.

According to some estimates, climate change has already affected some health outcomes (WHO 2003). McMichael (2006), however, argues that the correlation between the increase in temperatures of the last three decades due to climate change with health effects is difficult to demonstrate at this stage, mainly because of the interaction with other factors, such as ecological processes, social conditions, and adaptive policies. Also, he suggests that there could be indirect health effects due to social, economic, and political disruptions as a result of changes in regional food yields and water supplies. Furthermore, the effects of climate change could trigger refugee flows, together with their potentially associated effects on health, such as increased infectious diseases, malnutrition, injury and violent death[10].

5.6. Infrastructure

The thermal expansion of water bodies together with the melting of land-based ice-sheets and mountain glaciers will cause the sea level to rise. A 25cm sea level rise would result in the loss of 1015 km^2 of land in the EU, representing a minor fraction of about 0.032% of the total land area (Bosello et al. 2004). However, because human activities are historically gathered near low-lying coasts for commodity reasons, the stakes could be high. In the Netherlands for example, 60% of the population live in so-called low elevation coastal zones (McGranahan et al. 2006). Watkiss et al. (2005) estimate that, with about 89'000 km of coastline, 68 million people could be affected by sea level rise in the European Union. Economies relying on agriculture will suffer the most from sea level rise (Bosello et al. 2004).

The costs due to sea level rise seem relatively small in the EU (Darwin et al. 2001). Interestingly, those authors highlight a redistribution effect of the losses from regions with relatively high damages to regions with relatively low damages, implying that even countries without a coastline are likely to bare some burden of sea level rise. Costly protective measures may have to be

[10] Sea level rise will lead to land loss in coastal areas which is likely to trigger the displacement of resident populations, probably numerous million of people, mainly in Asia (IPCC 2001b).

undertaken in order to mitigate the impacts of sea level rise. Bosello et al. (2004) conclude that the costs of coastal full protection exceed the cost of lost land. Coastal protection may thus not be cost-effective in some areas. In contrast, Deke et al. (2001) reveal that, from an economic point of view, it would be better to protect coastlines from sea level rise. That argument, anyway, is only valid in cases where sufficient investment funds are available.

The impact of sea-level rise due to a moderate warming could reach 0.6% of the GDP in European OECD countries and 0.01% of the GDP in eastern European countries, according to the estimates made by Nordhaus et al. (2000), which are in line with those made by Deke et al. (2001). The latter argue also that investments in coastal protection have a small negative impact on capital accumulation, thus altering welfare slightly.

The frequency and intensity of storms are expected to increase in the future. In a recent study, the World Wide Fund for Nature (WWF 2006) reports the likely strongest increase to happen in the United Kingdom, the Netherlands and northern France, as well as on the north-western shores of Spain, although to a lesser extent. Due to the nonlinear relationship between wind-speed and damages, such increase could lead to significant economic losses in terms of infrastructures and buildings.

Palmer et al. (2002) evaluate the evolution of the probability of extreme precipitation events due to climate change. It appears that the probability increases slightly over much central and northern Europe. In contrast, it decreases over parts of the Mediterranean basin. Similarly, another study estimates that the probability of floods will increase significantly in the future (Milly et al. 2002). Mudelsee et al. (2003) demonstrate that there is currently no increasing trend of flooding events in central Europe. On the other hand, a report from the European Environmental Agency (EEA 2005) concludes that empirical data show an increasing tendency in the frequency of severe floods in recent decades. Beyond the debate on whether those trends are increasing or decreasing, there is the conviction that the danger is changing, hence altering the risk infrastructures are facing. For instance, even if the annual average precipitations decrease, more sudden precipitation events could increase the damages to infrastructure through landslides and mudslides. It has to be noted that, together with changes in precipitations, human activity plays an important role as well. For instance, deforestation in mountainous regions accelerates water runoff.

On the positive side, climate change may allow for less snow clearing and slating of road surfaces requirements. Also, icebreaker capacity in the North might decrease (Ministry of Sustainable Development 2005).

Table I.5: Potential effects of climate change on economic activity and employment related to infrastructures

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
Coastal Areas	Sea level rise	Loss of land. *Negative impact on employment due to the loss of land (agriculture and tourism for instance).*	Medium	
General	Increase in frequency and intensity of extreme weather events, floods	Destruction and damage of infrastructure and buildings, negative impact on economic activity. *Negative impact on employment.*	Medium-low	

5.7. Energy

There is a correlation between energy consumption and climatic conditions (López Zafra et al. 2005). The energy demand for space heating in winter is likely to decrease due to the warming. On the other hand, hotter summers could result in an increasing demand for air conditioning (EC 2006). For example, heating energy requirements in Finland are expected to have decreased by 10-14% during the period 2021-2050, compared to 1961-1990 (Venäläinen et al. 2004). Similarly, Cartalis et al. (2001) and Giannakopoulos et al. (2006) also observe a reduction of energy requirements for space heating in Greece. However, the increase of energy requirement for space cooling in summer seems to more than offset the winter gain. Moreover, more severe temperature extremes due to higher climate variability might exacerbate the peak in electricity demand during unusually hot or cold periods, with corresponding adverse consequences for distribution networks and production capacity.

Not only will climate change alter energy requirements, but also the conditions and potential for electricity production. The effect of climate change on hydropower production is mainly twofold. First, variations in rainfall affect hydropower generation potential. Secondly, increased temperatures enhance lake evaporation. Micro-hydroelectric power generators are more sensitive to precipitation changes than larger ones (Aguiar 2002). As an indirect effect it could also be mentioned that dam management could be affected by changes in the magnitude, frequency and timing of precipitations, including snowmelt (Arnell et al. 2000).

In northern Europe, where precipitations are expected to increase, hydropower electricity generation may be positively influenced while the opposite trend might be observed in southern Europe (EC 2006). In Nordic countries, hydropower represents a significant share of electricity production. Changes in its potential could have important consequences. Studies expect hydropower potential to increase due to climate change in Finland, Iceland, Norway, and Sweden (Bergström et al. 2003). Nevertheless, the extent to which that potential can be exploited is still uncertain. Indeed, changes in the temporal distribution of rainfall could be unfavourable and impede the concretisation of the potential benefit.

In contrast, low river water flows during hot and dry summers represent an issue for the cooling of thermal power plants, as experience in several European countries over the last few years has shown. Paradoxically, it is in such conditions that the electricity demand peaks due notably to high air conditioning requirements. Very high electricity demand combined with reduced generation

Table I.6: Potential effects of climate change on economic activity and employment in the energy sector

Geographical location	**Main climatic drivers**	**Expected potential effects on economic activity and *employment***	**Level of confidence**	**Remark**
General, northern Europe especially	Rising temperature	Reduced energy demand for space heating in winter, increased energy demand for space cooling in summer. *Mixed impact on employment in energy production and distribution*	Medium	
Nordic countries	Increased precipitations	Possible increase in hydropower generation potential. *Possible positive impact on employment.*	Medium-low	

capacity puts extreme constraints on production and distribution systems and thus contributes to their instability. Several regional black-outs have recently been experienced under such conditions. Also, the warming will decrease the efficiency of thermoelectric power plants (López Zafra et al. 2005), although the effect is expected to be rather small (Aguiar 2002).

Furthermore, climate change may alter wind energy potential by changing wind regimes. Models reveal an increase in wind-speed in the Baltic Sea and Gulf of Finland region (Clausen et al. 2004). No major changes are observed for Portugal by Aguiar (2002). Finally, bioenergy potential can be expected to be influenced by climate change in the same way as other agricultural products.

Finally, some of the energy systems infrastructure is at risk assuming more frequent and more intense extreme weather events. Also, energy carrier logistics could become troublesome in certain climatic conditions, for example low water levels could cause barge transportation restrictions.

6. Discussion

It is acknowledged here that, although climate change could have a significant impact in terms of economic activity and employment, other factors may be dominant. Indeed, overfishing, agricultural policies, technical changes in eastern Europe's agriculture, population and economic growth for tourism, taxes and financial incentives for energy, policies and measures in order to reduce greenhouse gases emissions[11], to quote only a few, could all largely outweigh the possible consequences of a moderate climate change. However, even a moderate climate change will influence economic activities and employment no matter what, and could either counteract or enhance other effects. The goal of this work is to isolate the effects of climate change in order to highlight and evaluate their potential consequences.

Very little information about the direct effects of climate change on employment could be gathered during the interviews and the literature review, revealing a study gap. During the interviews, the perception that other drivers, such as the one mentioned in the previous paragraph but not only those, prevailed. Nevertheless, most of the interviewees are conscious of the fact that climate change will directly, as well as indirectly, affect their sectoral activities to a certain extent. Often, however, the potential magnitude of such effects results difficult to estimate.

The interviews also revealed a very dissimilar degree of involvement in terms of climate change issues. Unfortunately, the sample does not allow for further analysis in this regard. Such examination would also derive from the objectives of this study. An important message that can be extracted from the interviews is the plea for information to be a prerequisite in order to

[11] For a discussion on such impacts, please refer to the other section of this research project.

facilitate an adaptation to climate change induced alterations. In that sense, the interviews, together with this report, facilitate the start of the debate and might serve as awareness raising support.

The literature on the effects of climate change is abundant. However, great care is required while comparing such studies. Indeed, methodologies, assumptions and static or dynamic models differ greatly, preventing a straightforward data association.

6.1. Local vs. global, direct costs vs. general equilibrium

One can observe an increase in the application of general equilibrium models to evaluate the impacts of climate change in recent years. This kind of approach presents the notable advantage of being capable of dealing with some of the complexity of climate change impacts, while avoiding geographical or sectoral limitations. On the other hand, such methodologies, normally applied at a rather large scale, mask regional effects and distribution of losses and gains (Darwin et al. 2001), which in many cases are very relevant to employment. Although global impacts might be negligible when assuming a moderate and gradual climate change, regional effects could be significant. On the downside, however, regional studies offer incomplete perspectives (Adams et al. 1998) and rarely adequately take into account knock-on and redistribution effects. Also, they are based on down-scaled climate models which entail a higher degree of uncertainty than global models. In general, sectoral or regional studies report higher impacts than general equilibrium ones (Bosello et al. 2005), confirming the relevance of inter-sectoral and international redistribution effects.

6.2. Uncertainty

Most notably, the very nature of climate change, a bewildering complex interaction of natural variability and anthropogenic forcing, represents a challenge for future predictions. Significant uncertainty embodies climate change impact projections. They are of at least two types, according to Arnell et al. (2000). On the one hand, uncertainty results from the incomplete scientific knowledge and models. On the other, there is inherent uncertainty in regard to the development of the world's economy and society in the next decades. Also, uncertainty about the potential response of socio-economic systems and adaptation potential render reliable estimates of climate change impacts complicated.

6.3. Non-linear and abrupt changes

According to climate research, human civilisation has experienced a relatively stable climate. Previous climate system patterns have not always been as moderate. There are evidences from paloeoceanography notably for sudden major changes in the climate system (see Martrat et al. 2004) triggered by sometimes relatively small perturbations. The warming is believed to increase the risk of abrupt and large-scale changes (Stern 2006). Human-induced climate change could potentially alter major mechanisms by perturbing the Atlantic Thermohaline Circulation or enhancing the melting of land-based ice-sheets. Recent evidences suggest that reaching such tipping point could lead to external drivers of change to be replaced by self-sustaining internal drivers (van Schalkwyk 2006), possibly triggering irreversible changes across the globe. As an example of positive feedback, the decrease of the area covered by ice-sheets changes the albedo coefficient (proportion of sun radiation reflected) and thus the amount of energy reflected back to space. That is, the less ice there is, the more energy heats up the earth, in turn accelerating the melting of the ice. The consequences of such scenarios are ungraspable and usually not integrated in assessment studies on the impacts of climate change.

Paleoclimatology research indicates that drastic and sudden climate changes happened in the past. The relative stable period of the Holocene (past 10'000 years) might be a rather misleading signal of partial equilibrium since the climate system is highly kinetic and records suggest for dramatic climate changes to have taken place in only a few decades in the past (Kennedy et al. 2006).

6.4. Adaptation

As the climate system is changing, socio-economic systems will need to adapt to the new conditions. Measures of adaptation will also have potentially huge consequences in terms of employment. For instance, additional coastal protection will be required in some areas in order to mitigate the effects of sea level rise. Quite obviously, such undertakings influence economic activity and employment. For example, one can expect an increase in the demand for construction workers and civil engineers. Nonetheless, the capital invested in adaptation measures will not be available for other purposes, which would also have an impact on economic activity and employment. The net benefit in terms of employment is therefore ambiguous. As far as the insurance sector is concerned, climate change may lead to an increased demand for insurance products. On the other hand, insurers might respond to the increased risk by raising premiums offer deals with tougher contractual terms. The evaluation of the effects of adaptation measures on employment, however, does not represent the main focus of this study.

7. Conclusion

A moderate, gradual climate change will cause a mix of positive and negative impacts on economic activity and employment, with substantial disparities among regions in Europe. Several studies demonstrate that a more severe warming would be detrimental overall, with an increased risk of non-linear responses and abrupt changes.

In general, modest changes in climatic conditions are expected to have a relatively minor impact at macro level in Europe due to redistribution effects and adaptation capability. However and even under such optimistic scenario, climate change could have significant adverse impacts at local level in terms of economic activity and employment. Numerous studies highlight the importance of redistribution effects between economic sectors, as well as between regions. Employment, however, is sensitive to changes at local level. Communities relying on primary sectors, such as agriculture, forestry, and fisheries, are the most vulnerable to the effects of climate change.

In Europe, the balance of impacts is expected to be more negative at low than mid- and high-latitudes. In southern Europe and the Iberian Peninsula in particular, water shortages, which currently already represent an issue in many areas, could be exacerbated by climate change. The availability of water already represents a constraint to several crucial sectoral activities, notably agriculture and tourism. In Germany, a balance of positive and negative impacts on economic activity is foreseen. Central Europe in general is particularly exposed to extreme weather events, especially floods. In Scandinavia, the impacts of climate change on economic activities at national level are anticipated to be slightly positive, although masking possible significant adverse effects in regions mainly depending on climate-sensitive resources.

Warmer temperatures are expected to increase agricultural productivity according to some models, and hence employment in the sector, in mid- and high-latitudes regions. The potential positive impact on agriculture in northern countries has been questioned in recent studies. Climate change will adversely affect agricultural productivity in the Mediterranean region. Also, the increase of forest fires is expected to be detrimental to employment in the forestry sector, in southern Europe especially. The effect of climate change, by enhancing species migration, can significantly affect fisheries communities. Furthermore, employment alternatives are commonly scarce in such contexts.

Many regional economies rely on tourism. The climatic attributes of a destination often represent a key determinant for tourists. Cool destinations could become more attractive as the climate warms up. In contrast, already warm destinations might become too hot for summer coastal tourism. Tourism demand in beach resorts, typically around the Mediterranean, could see its seasonal peak flattened with fewer tourists in relative terms in summer, but more in spring and autumn. Also, ski resorts will be affected by the warming. Changes in snow conditions will alter the economic viability of low altitude resorts principally, issue which is further worsened by the fact that ski resorts are mostly located in rural areas where employment substitutes are limited in winter.

Insurance companies, and the financial sector in general, are exposed to the impacts of extreme weather events. The changing probability of extreme weather events will affect the functioning of insurance markets through an increase in insurance claims and an impact on the significant assets portfolio companies in the sector hold and manage. Climate change outside Europe will also affect European insurers for their involvement in activities abroad. Increased losses due to damage claim will augment the pressure on insurance companies, particularly small ones, possibly further enhancing the structural changes the industry is currently going through. On the bright side, there might be new opportunities arising due to climate change, such as an increased demand for insurance products and services.

Moderate climate change should reduce cold-related diseases and increase heat-related ones, with a probable net positive balance in Europe. Such an effect is likely to be positive in terms of employment as labour productivity should increase. On the other hand, there might be a related slight negative impact on employment in the health sector due to the decreased requirements for health services. Extreme weather events are expected to increase the need for health and psychological care. The risk of malaria propagation in Europe is believed to be relatively low due to the privileged socio-economic conditions and effective health systems.

Sea level rise will cause a loss of land, affecting agricultural activities and tourism for instance, if not prevented by costly coastal protection equipment. The increase in both frequency and intensity of extreme weather events will provoke damages to infrastructure and buildings.

The warming will reduce energy requirements for space heating and increase, on the other hand, electricity needs for air conditioning in summer, causing a mixed positive and negative impact on employment in the energy sector. Climate change will also affect energy generation. The hydropower potential could increase due to more affluent precipitations in northern Europe. On the contrary, low stream flows in summer restrict thermal power plants capacity.

Very little information directly relating climate change to employment could be obtained either during the interviews or through the literature review. Other drivers than climate change influencing economic activity and employment are often perceived as predominant, if not superseding, by stakeholders. Nevertheless, the interviewees often underlined the necessity for information with regard to climate change issues in the context of economic activity and employment in particular, requisite to which this research project hopefully contributes.

Part II

Overall impact of CO_2 emission reduction measures

1. Objectives

The study aims to estimate the potential costs and benefits for employment of measures intended to reduce greenhouse gas emissions in the European Union. It also aims to supply recommendations both for European climate policy instruments and at the same time for social support policies. The ultimate objective of the project is to lay the foundations for prospective management of jobs and skills in Europe and for a mode of social dialogue at the sectoral, cross-sectoral and enterprise level answering to the demands of a low-carbon economy and society.

For the part of the study relating to the impact of policies and measures intended to reduce CO_2 emissions, the specific objectives are the following:

- to evaluate quantitatively job movements within and between economic sectors resulting from structural changes required to reduce emissions;
- to evaluate qualitative changes to jobs resulting from these changes;
- to identify obstacles and points of resistance connected with employment and skills which retard or oppose the development of "winning" activities;
- to estimate the potential to retrain workers from areas of activity that are negatively affected.

2. Hypotheses

The study considers two time-horizons: 2012, which corresponds to the first period of application of the Kyoto Protocol, and 2030, which produces discontinuities which are likely to profoundly change the course of development of economic sectors and of employment.

The basic postulate of the study is that the EU respects the targets in relation to emission reductions in 2012 and 2030. This corresponds to a reduction of 8% in 2008-2012 by comparison with 1990 imposed by the Kyoto Protocol, and a reduction of 30% to 50% in 2030 by comparison with 1990 corresponding with an extrapolation of the figures advanced by the European Council and the Environmental Council of March 2005 (-15% to -30% in 2020 and -60% to -80% in 2050).

The scope of the study is limited to carbon dioxide (CO_2) emissions linked to energy and to four economic sectors which, alone, represent 80% of the EU's greenhouse gas emissions: energy production, transport, manufacturing and building/housing (Table II.1).

3. Sectors in the study

The study covers four sectors (Table II.1).

Table II.1. The sub-sectors in the study

Sub-sector	Specific activities included
Energy production	Electricity generation Petroleum Bio-fuels
Transport	Passenger transport: road, rail, urban mass transport, intermodality Goods transport: road, rail, maritime, intermodality
Industry	Iron and steel Aluminium Cement
Building	

4. Social and economic impact of policies to counteract climate change

Policies aiming to reduce greenhouse-gas emissions, if they do not bear directly on employment, affect it indirectly in various ways. They may change the relative production costs depending on emission levels, alter the demand for products and technologies through the introduction of regulations and standards, or again orient R&D and innovation towards low-emission processes.

The influence of anti-climate-change measures on employment has been little investigated until now. Available studies belong to three categories: studies based on macroeconomic models (OECD[12], etc.), studies that evaluate the potential for job creation in sectors which undeniably benefit from the fight against climate change, in particular renewable energy sources and thermal insulation of buildings, and studies that estimate the effects of a single policy instrument, for example the eco-tax[13].

It emerges from these studies that:

- The macroeconomic impact on employment of controlling emissions would have a small, but positive, effect on overall employment;
- This redeployment will accelerate the sectoral transformation of our economies, at the expense of manufacturing sectors and those making heavy use of fossil fuels (automobile transport, for example).
- New professions and industries will develop, in both public and private sectors. Particularly in renewable energy sources, electricity and heat co-generation technologies, energy-efficiency technologies, manufacturers and installers of heating and insulation materials, energy advising and audit activities, and public transport.
- In traditional sectors, new activities will develop and old activities will be re-skilled. Thus new forms of energy services would have to come into being in electricity companies.
- If the labour market functions badly, in particular if the geographic or sectoral mobility of employees is insufficient to compensate for the relative decline of certain activities, this redeployment could entail transitional unemployment.

These studies take incomplete account of the effects on employment. The potential cost of the transition for employees in "losing" sectors is not appreciated, nor is the vulnerability of some categories of workers in relation to the opportunities for re-skilling. Because of this, irreversibility effects are underestimated: the unemployment of displaced workers could become structural if developments are not correctly anticipated and followed up. Finally, the potential obstacles to the development of new jobs in the "winning" activities are not identified.

[12] OECD, 1997 and 2003.

[13] Conseil d'analyses économiques, 1998 ; Kohlhaase, 2005.

It is crucial in two respects to appreciate the nature, the magnitude and the significance of such effects. It allows the right climate policy decisions to be taken, favouring those policies which, environmental efficiency being equal, generate more jobs and social benefit, or minimise the costs for employment. Currently, the opportunity analysis of climate-related measures is limited to looking for the least cost per tonne of carbon saved. It also allows us to conceive prospective job and skills management policies in Europe answering to the demands of a low-carbon economy. These elements are crucial to ensure the public acceptability of policies for climate-change prevention.

5. Methodology

The methodology used to estimate the impact on employment of climate policies has the following characteristics:

- the definition of scenarios of policies and measures for reducing CO_2 emissions with a 2030 time-horizon,
- the systemic approach,
- quantitative analysis applied to economic sectors
- combination with a qualitative and empirical approach,
- articulation of national and European variables.

5.1. *Definition of scenarios of policies and measures*

The long-term effect of European climate-change-prevention policies on employment is particularly difficult to evaluate and to predict in relation to policies still under development, which are likely to evolve significantly over the coming decades. Only simulations of alternative scenarios are possible.

The study is articulated around three principal scenarios, consisting of a reference scenario ('business as usual') and two alternative scenarios of policies and measures for reducing CO_2 emissions (cf. point 6.3.).

Although these scenarios take into account the totality of sectors relevant to CO_2 emissions, they target the energy sector and more particularly electricity production, and tend to treat other sectors, notably transport and manufacturing, in less detail. To evaluate the consequences on employment in these latter sectors, the examination of sectoral scenarios turned out to be necessary.

5.2. *The systemic approach*

This approach is in keeping with a systemic perspective where account is taken both of contextual factors influencing the behaviour of economic and social players and at the same time the dynamics of the players composing the environment in which they evolve.

Bearing in mind the difficulty of establishing a direct causal link between climate policy and employment, we analyse the causal links between climate-related policies and climate-related measures and economic, technological and strategic variables, which in turn are linked to employment. These variables include: the level of activity, infrastructure, technology, consumer behaviour and the competitiveness of the sector at the global level.

5.3. Quantitative analysis applied to economic sectors

The quantification of potential effects of climate policies on employment is conducted at the level of selected economic sectors. In view of the method used, the figures put forward are raw figures reflecting the number of jobs lost or gained in each sector considered.

The effects may be observed in the shorter or longer term, depending on the type of job created. These may be direct and/or indirect effects.

It is important to underline that this approach does not allow us to quantify net effects on employment resulting from "displacement" and redistribution effects on the economy as a whole. However, when these mechanisms are significant, methods based on general equilibrium models are used to give indications of the nature of job transfers between sectors which are likely to occur in these conditions.

As far as possible, the dynamics of sectoral employment induced by climate policies is estimated from evolutionary trends of the mix of branches considered in terms of volume of activity within the sector supplied by the selected scenarios. In this case, the job figures correspond to calculated figures and are not determined directly.

The figures are calculated using a method of calculation based on:

- volumes of activity for 2000, 2020 and 2030,
- ratios of job-intensity (number of jobs per total volume of activity in the sector).

The estimation of the job-intensity ratios relies on existing work which takes account of the jobs generated by the activities considered.

5.4. Combination with a qualitative and empirical approach

The quantitative analysis is complemented by a qualitative and empirical analysis, which aims to determine:

- the potential impact on the quality of jobs, the indicators considered being skills, working conditions, the status of jobs (sub-contracting, mainstream employment);
- the capacity of different types of employees to adapt to structural changes, and strategies developed by the players. In terms of employment and skills, a quantitatively small impact may have a bigger effect on a vulnerable population than a larger impact on less vulnerable players;
- the possibilities for social support of transitions.

This approach rests on interviews with the players, conducted in each sample country as well as at the European level: businesses, public authorities, local councils, unions, environmental NGOs, research institutes. On average, around fifteen interviews per country were carried out, some face-to-face, others by telephone. In several countries, the difficulty of getting appointments limited the number of meetings.

Apart from gathering data, another important role of the interviews was to raise the awareness of the players about the links between climate policy and employment.

In practically all countries, the players had the opportunity to discuss the results of the national case studies.

Meetings were organised at Brussels to present the preliminary results of the study to union experts as well as to the study's steering committee, composed of representatives of the financing organisations and of the European trade-union federations for the sectors concerned in the study.

5.5. *Articulation of national and European variables*

The study analyses interactions between national variables and European variables in terms of the impact of climate policies on employment. This allows this study to be of assistance to national, possibly also regional, competences in the field of employment and initial and continuing job training, which must be mobilised to support the implementation of climate policies.

The national case studies bear on 11 EU countries: Belgium, the Czech Republic, Finland, France, Germany, Hungary, Italy, Poland, Slovenia, Spain and the United Kingdom.

This sample of countries can be considered representative of the diversity of situations existing in the 25-member EU in relation to questions of employment linked to climate-change policies. It comprises:

- countries from the Union before 2004 and countries from the 2004 expansion, inasmuch as the problems are very different, in the areas of both transport and energy;
- countries representing varied situations in terms of energy mix, in particular nuclear production vs. programmed shut-down of nuclear energy;
- countries representing a broad range of targets under the Kyoto Protocol, from -25% to +15%[14].

[14] Germany -21%, United Kingdom -12.5%, Belgium -7.5%, Italy -6,5%, Finland 0%, France 0%, Spain +15%, Czech Republic -8%, Hungary -6%, Poland -6%, Slovenia -8%.

6. The relevant emission reduction policies, the scenarios

6.1. *The relevant climate policies from now until 2030*

It is very probable that the European system of countering climate change, based on more or less successfully implemented national plans and on community action which is being strengthened, will continue over the period considered in the study.

EU policies

It is possible to predict without too much uncertainty the emission reduction policies and measures that will be applied between now and 2008-2012, because of the numerical targets resulting from the Kyoto protocol on one hand, and the policies already currently adopted on the other. Beyond 2012, by contrast, the mix of measures that will be applied is tricky, if not impossible, to predict, hence the need in this study to make use of scenarios describing possible emission reduction options between now and 2030.

Nevertheless, we can identify the principal levers that will be put into action, from the measures already undertaken (Table II.2) and the guidelines adopted by the Commission[15]. The policies and measures that are relevant for the study are energy efficiency policies, supply-side energy policies, the European Union Emissions Trading Scheme (EU ETS), transport policy and R&D policy.

[15] Communication entitled "Winning the battle against global climate change" (COM 2005)

Energy efficiency policies

There is near-consensus that energy savings are the fastest and most economical means to allow the EU to reduce its greenhouse-gas emissions. This activity is also considered to be a strong creator of jobs.

In October 2006, the Commission published an Action Plan on Energy Efficiency, which aims to achieve 20% savings in energy by 2020 and thus save 780 million tonnes of CO_2 by 2020, which represents twice the Kyoto target. The proposed actions aim to reinforce existing directives which promote energy efficiency of buildings and of appliances and equipment using electricity; to encourage energy efficiency investments in social housing, in particular in the new Member States, by mobilising structural funds; to facilitate the financing of energy service companies that want to realise the energy savings suggested in energy audits; to develop vocational training plans for energy efficiency through Community programmes.

The measures recently adopted should produce their effects by 2010. The most relevant for the subject of the study are the directive on the energy performance of buildings and the directive on the final uses of energy and energy services. The first directive, which came into effect in January 2006, obliges Member States to establish minimum standards of energy performance for new buildings and large renovated buildings, and requires vendors and lessors to supply a certificate of energy performance (CEP) to purchasers and lessees.

The directive on the final uses of energy and energy services, adopted in December 2005, requires Member States to define national action plans in order to achieve energy savings of 1% per year over a period of nine years, from 2008 to 2017. The target is only indicative, but the national action plans must be approved by the Commission and must be revised every three years. The directive contains an obligation for distributors and retailers of energy to offer more energy-efficient measures ("energy services") to their customers, and obliges them to take account of energy efficiency in public tenders.

The EU CO_2 emission trading system (ETS)

The emission quota trading system, which came into force at the beginning of 2005, is the cornerstone of European policy in the area of climate change. It limits the CO_2 emissions of about 11,500 installations in the 25 Member States of the EU, through the allocation of emission permits by the Member States. The permits are exchangeable in order to reduce the costs of implementing the Kyoto commitments[16].

This mechanism concerns the following sectors: electricity generation (more precisely combustion installations with a calorific combustion power greater than 20 MW), refineries, the steel industry, glass production, cement production and the paper industry.

Apart from this, enterprises participating in the EU exchange system have the possibility of using the credits resulting from emission-reduction projects carried out outside the EU in the framework of the flexibility mechanisms of the Kyoto protocol (Clean Development Mechanism (CDM) and Joint Implementation (JI)) to achieve their targets for reduction of greenhouse-gas emission.

The Commission has recently proposed prolonging the ETS beyond 2012 and expanding the ETS to other gases and other sectors from 2013[17]. In December 2006, it adopted a proposed directive aiming to include aviation from 2011.

Supply-side energy policies

The promotion of renewable energy is one of the few areas in which the EU enjoys a *droit de regard* (monitoring rights) over national energy mixes. The directive on "renewable electricity" adopted in 2001[18], is supposed to increase the share of electricity in the EU produced from renewable energy sources from 15.2% (2001 level) to 21%, and thus contribute to the general objective of

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[16] Cost reductions are estimated at 1.3 billion euros per year.
[17] Communication "Building a global carbon market – Report pursuant to Article 30 of Directive 2003/87/EC", COM (2006) 676
[18] Directive 2001/77/EC on the promotion of the electricity produced from renewable energy source in the internal electricity market.

getting the share of energy consumption coming from renewable energy sources to 12% by 2010.

Numerous Member States currently say they are unable to achieve their national objectives. The European Commission has incorporated this delay by aspiring to 18% rather than 21%. Nevertheless, discussions are currently taking place on the adoption of even more ambitious objectives for 2020, the European Parliament having declared itself in favour of a target of 20%.

Cogeneration

The 2004 Directive on Promotion of cogeneration of heat and electricity (2004/8/ EC) provides a framework for the promotion of this efficient technique in order to advance its penetration in the liberalised energy markets. The Directive urges Member States to carry out analyses of their potential for high efficiency cogeneration.

The Directive defines high efficiency cogeneration as cogeneration providing at least 10% energy savings compared to separate production.

Transport policy

The integration of climatic constraints into transport policy has progressed only very slowly to date. The guidelines offered by the White Paper of 2001 “European transport policy for 2010”, COM (2001) 370, have not all been put into effect, in particular the objective of modal shift from road transport towards less greenhouse-gas-emitting modes of transport (rail, inland navigation, metro, bicycle, etc.).

The three main pillars of European transport policy are currently the following:

- The voluntary commitment entered into with the association of European car manufacturers to reduce CO_2 emissions of new private cars to 140 g/km by 2008 (174 g/km in 1999). In any case, this commitment is unlikely to be honoured.
- The “Eurovignette” directive adopted in 2006 allows Member States to impose taxes on heavy vehicles over 3.5 tonnes and obliges, from 2010, countries that already charge tolls or road taxes to vary their levels according the pollution standards of the vehicles so as to favour less polluting vehicles.
- The promotion of the use of biofuels in transport. In 2003, the EU adopted a directive encouraging Member States to set indicative targets for the introduction of a minimum share of biofuels on the market: 2% in 2005 and 5.75% in 2010.

The revision of the 2001 White Paper, published in 2006, revises the objective of “mode shift”, which is replaced by the objective of co-modality. The revision does not hint at the development of an ambitious strategy or reducing emissions from the transport sector. Advances could come from the following measures:

- The internalisation of environmental costs through common principles for charging for infrastructure usage: in 2008, the Commission will present a model concerned with charging for infrastructures, based on the evaluation of all the external costs of all modes of transport;
- The development of co-modality: support for logistical activities
- An urban environment strategy aiming to reduce greenhouse-gas emissions, urban pollution and congestion.

The use of taxes to internalise the social costs of transport has so far run up against major forces of inertia within the Member States, on a subject requiring unanimity of Member States.

Emissions from transport continue to advance and have increased by 26% since 1990.

Research and development

The proposal for the EU’s seventh R&D framework programme (2007-2013) has significantly increased the budget for research on climate change, energy and transport technologies from 2007 to 2013. ¾ 8.4 billions have been dedicated to these themes.

Other policies and measures

The use of energy taxes for European environmental ends still remains very little advanced. Despite its adoption after several years of negotiation, which is a success in itself, the

2003 directive on the taxation of energy products will very clearly be insufficient to orient national choices towards a reduction in consumption and towards more environmentally friendly energy sources.

The liberalisation of the electricity and gas markets has been to this date the driving force of European action in the field of energy. However, its ultimate impact on the level of greenhouse-gas emissions is not clearly established. Increased competition between different energy sources is supposed to favour flexible, less capitalistic and smaller-scale production methods, corresponding to forms of energy production emitting less CO_2. The arguments in the opposite direction are, however, numerous.

The policies of the 11 Member States taking part in the study for 2012 and 2030

The relevant national policies and measures to counteract climate change are analysed in detail in the national reports. This section only contains a summary that highlights the principal points they have common and points of divergence.

A near-absence of projection beyond 2012

All the Member States studied have prepared a national strategy against climate change for 2010 or 2012, thus coinciding with the first application period for the Kyoto Protocol. The accompanying action plans are often drawn up for shorter periods and cover between 3 and 5 years. In general, the emissions reduction target is the target assigned to the country by the Kyoto Protocol. Only the British and German governments have respectively set themselves more ambitious targets of a reduction of 20% (instead of 12.5%) a reduction of 25% in 2005 (instead of 21%) over the period 2008-2012.On the other hand, only four Member States have either developed greenhouse-gas emission reduction scenarios or defined strategies with quantitative targets for emissions reduction beyond 2012. All types of uncertainties, but above all those affecting post-Kyoto international commitments, make it difficult to develop long-term greenhouse-gas emission-reduction policies. In the United Kingdom, forward thinking was taken as far as 2020 and 2050, with a target of a reduction of 60% by 2050 compared with levels recorded in 2000. In France, a reduction of 75% of emissions by 2050 was studied by the "factor 4" working group. In Germany, a target of 40% less emissions by 2020 has been set if the EU agrees to a reduction of 30%, The country already has a transport strategy for 2020 and a national energy strategy should be defined by mid-2007. In the Czech Republic, the national climate change programme has set a target of a 25% reduction in CO_2 emissions by 2020 in comparison with levels recorded in 2000.

Common points contained in the national plans for 2012

Energy-efficiency measures are seen as an indispensable solution that need to be implemented in all highly energy-intensive sectors in the short term. All plans contain targeted measures to improve the energy efficiency of buildings.

All national plans provide for an extension of the percentage renewable energies represent in electricity generation, co-generation and biofuels. The quantitative objectives are those established by European directives. Only those countries that are already ahead (Germany, Spain) foresee exceeding EU objectives.

With the exception of Germany, none of the Member States studied has developed a voluntary policy to reduce transport emissions. The German plan continues several measures targeted at transport: efforts to encourage the use of rail freight, highway tolls for heavy vehicles, tax reductions for vehicles emitting less than 120 g/km of CO_2 and continued increases in fuel prices, as started in 1999.

The national allocation plan, developed as part of the EU ETS directive, is the central element of climate strategies followed by all of the countries studied due to the legally binding nature of these plans and the control exercised upstream by the European Commission on the number of emission permits accorded to the states.

Apart from the sectors covered by national allocation plans (manufacturing and energy sectors), most Member States have not set any sectoral emissions reduction objectives.

There does not seem to be any strategy on the part of the new Member States in possession of excess emissions to capitalise on this surplus by attracting Joint Implementation (JI) projects. Thus, a country like the Czech Republic, which has a major energy efficiency potential (energy intensity in the Czech Republic is lower by a factor of two than that of the EU countries), could enjoy major economic benefits if it implemented an exhaustive anti-emissions strategy.

The points of divergence between the national plans for 2012

Whereas certain states (Spain, Germany) have put in place a complete range of policies and measures covering all sectors responsible for CO_2 emissions (energy, manufacturing, transport, tertiary and domestic), other countries (Hungary, Czech Republic), only have strategic objectives for some sectors or potential reductions. In this latter case, the sectors most often covered by strategic objectives are energy efficiency and renewable energies; the least covered sector is transport.

The choice of energy mix compatible with the Kyoto objectives is a question which makes sharp distinctions between the national anti-climate-change plans. Some countries give priority to renewable energies or to "heat-electricity" co-generation, in particular the countries that were already the first to use renewables (Spain, Germany for renewables, Finland for co-generations), others emphasise the importance of nuclear energy for electricity generation to achieve ambitious emission reductions, either because of their low potential for renewable energy development (Czech Republic), or because they already have a large nuclear capacity (France).

Only a few national plans (Germany) include promotion of research and development as a force for reducing emissions. In this case, innovation is seen as a medium and long-term solution, which should allow the creation of the necessary technological breakthroughs for new emission reductions, in industrial sectors that operate close to the leading edge of technology (iron and steel, for example), in the automotive sector where the dependence on petroleum is near-total, in the energy sector (renewables, hydrogen and fuel cell) or in several sectors in the case of carbon capture and storage.Some Member States envisage intensive use of flexibility mechanisms, through public investment in the CDM and JI projects supplementing enterprise investments, to achieve their Kyoto objectives (Spain, Italy, Belgium, Finland), while others think they can achieve their objectives by domestic measures alone.

6.2. The evolution of EU emissions

Emissions in 2004

At the date of the last available inventory (2004), the total emissions of the EU-15 were only 0.9% lower than in 1990, if one excludes land usage (LULUCF), and 3% lower with LULUCF.

The principal cause of the increase in CO_2 emissions between 1990 and 2004 was the increase in the demand for transport and the emissions that resulted (up 26%). In all countries except Germany and Luxembourg, emissions linked to transport have increased over the past 10 years and will continue to increase if additional measures are not taken.

CO_2 emissions from manufacturing have fallen considerably (down 11%) since 1990, primarily as the result of the closure of heavy industries in Germany's 5 new states following reunification.

Emissions in the energy sector (up 6%) have gone up, but less rapidly than petroleum consumption, mainly because of the substitution of gas for coal in electricity generation in the United Kingdom and in Germany.

Prospects for 2008-2012

According to a Commission study carried out in 2000, greenhouse-gas emissions should only decrease by 1.4% between 1990 and 2010 on the basis of policies already in place. The European Union will therefore only be able to keep its Kyoto objective of an 8% reduction compared with the 1990 level thanks to exceptional efforts by the most virtuous countries, additional policies and measures implemented, the use of Kyoto flexibility mechanisms (CDM and JI) or carbon pits.

On the basis of the trend of emissions in 2004, two Member States could achieve their objectives by 2010 using only domestic policies and measures (Sweden and the United Kingdom). Six Member States predict that they will exceed (Finland, Luxembourg, the Netherlands) or achieve (Germany, France, Greece) their commitments by additional measures and/or Kyoto flexibility mechanisms and/or resorting to carbon sinks. The remaining Member States (Austria, Belgium, Denmark, Spain, Ireland, Italy, Portugal) anticipate that they will miss their targets despite the implementation of additional measures or the use of the Kyoto mechanisms or carbon sinks.

All new EU Member States, except Slovenia, are seeing emissions decline due to the industrial restructuring that followed the fall of communism in 1989. They should not find it difficult to comply with their reduction obligations. Slovenia expects to meet its objectives by applying new measures and including CO2 capture through land use change and carbon sinks.

6.3. *The scenarios*

Three scenarios have been chosen to describe the alternative options for policies and measures to reduce emissions in Europe by 2030.

- A reference (business-as-usual) scenario, based on the continuation of current trends in energy production and of existing energy policies. This scenario uses the Primes scenario, Mantzos et als, 2003. The BAU scenario includes some policies supporting renewables and energy efficiency, as well as the nuclear exit decisions taken by several Member States, but does not envisage additional measures to reduce greenhouse-gas emissions.
- Two alternative scenarios which reflect active and ambitious greenhouse-gas reduction strategies which suppose targets compatible with the reduction ranges proposed by the Environment Council of March 2005:
  - ⇨ **The "WWF/WI" scenario**, developed by the Wuppertal Institute for the WWF in 2005, also using the PRIMES model as a reference scenario. For this scenario, the long-term objectives are 2.15% less CO_2 emitted on average per year over the period 2000-2030.
  - ⇨ **The "EEA nuclear" scenario**, corresponding to the "accelerated nuclear" variant of the "carbon-poor trajectory" developed by the European Environment Agency (EEA) on the basis of the LCEP model (low carbon energy pathway).The scenario describes a reduction of 3.09% per annum over the period 2000-2020, or a reduction of 20% by 2020, a reduction of 40% by 2030 and a reduction of 65% by 2050 (basis 1990).

The general hypotheses concerning population movements and GNP growth (doubling of the EU's GDP between 2000 and 2030) are the same for the three scenarios.

The WWF/WI and EEA nuclear scenarios share the following hypotheses:

- The reduction in CO_2 emissions is partly due to energy efficiency which leads to a reduction in the demand of electricity-consuming sectors, notably residential and manufacturing, reflecting the unhooking of the rate of growth of electricity generation from GDP growth, especially for the WWF/WI scenario.
- The emissions reduction principally concerns the energy sector, currently responsible for 80% of total greenhouse-gas emissions in the EU.

Table II.2. : Short description of three different scenarios for the development of Europe's energy and emissions until 2020/2030

Scenario	Description
BAU/PRIMES *Business as usual* *(Mantzos et al, 2003[1])*	Continuation of the current policy including with its policies and measures; no focus on an active climate or energy policy, the European emission targets are not reached.
WWF/WI policies and measures *(Lechtenböhmer et al., 2005[1])*	Active climate policy: first priority are energy efficiency/energy saving measures; an enforced emissions trading system, a better market penetration of renewable and combined heat and power-technologies; completion of the exit from nuclear energy that was begun in some countries; no new nuclear power plants; special focus on the transport sector; a Europe-wide eco-tax and a reform of the subsidies policy.
LCEP-Nuclear-Scenario *(EEA, 2005[1])*	The climate protection targets can only be reached through substantial reduction of GHG outside of Europe; within Europe, energy efficiency is given first priority; a further change of the fuel-mix is only relevant on a long-term basis; intensification of emissions trading; 40-50 new nuclear power plants and re-evaluation of the nuclear-exit strategies already decided upon; fixed target quota for renewable energy; reform of the current subsidies policy; enforced promotion of research & development; increased awareness for ecological issues.

In all three scenarios, the transport sector remains a difficult area for emissions reductions. The WWF/WI and EEA/nuclear alternative scenarios predict that CO_2 emissions from transport will continue to increase (exceeding their 1990 level by 25-28% in 2030) because of the regular growth in demand for passenger and goods transport. The scenarios do not anticipate structural change in the relative shares of the various modes of transport (road/its alternatives). Substitution of traditional fuels with biofuels is a common hypothesis applied in both alternative scenarios.

Capture and storage of CO_2 has not been taken into account as an emission reduction option.

The WWF/WI and EEA nuclear scenarios differ on several points:

- The WWF/WI scenario envisages a significant drop in demand for energy. On the basis of a reduction in energy use[19] of 2.1 to 2.7% per year between 2000 and 2020, the final energy demand reaches a peak in 2010, and then falls in 2020. Such an increase in energy efficiency is a pre-requisite for renewables to be able to contribute significantly to electricity supply and thus compensate for the exit from nuclear energy and from coal, and the reduction in the use of other fossil fuels.
- A strong differentiation of the technological mix in electricity generation, with a predominance of renewable energies for the "WWF/WI" scenario (40% of electricity generation by 2020 for the EU-25) and of nuclear/gas for the "EEA nuclear" scenario: 30% for nuclear and 38% for gas as against 21% and 44% respectively for the reference scenario. The EEA nuclear scenario foresees the construction of 40 to 50 power stations by 2030, whereas the WWF/WI scenario makes the assumption that nuclear exit commitments will be respected and no new nuclear power station will be built.
- Cost of implementing the scenarios: the "EEA nuclear" scenario estimates that the reduction of emissions will be achieved at an annual additional cost of ¾100 billion in 2030 (around 0.6% of GDP in 2030[20]) in comparison with the reference scenario, and an increase in the price of CO_2 from ¾20/t in 2020 to ¾65/t in 2030. In comparison with the reference scenario, the development of renewables on a large scale in the "WWF/WI" scenario leads to an increase in electricity generation costs from 2010. These higher costs, however, are largely compensated for by a reduction in demand due to increased energy efficiency. As a result of the price level for fossil fuels, the costs in 2050 are comparable for the two scenarios.

It should be noted that the hypotheses used in relation to fossil fuel prices are relatively conservative, since the PRIMES 2003 scenario does not include the petroleum price rise which intervened in 2005. Any additional increase in these prices will increase the cost of electricity generation from fossil fuels, and, in doing so, will reduce the cost difference between the alternative scenarios and the reference scenario.

This results in a fundamental difference as regards the issue covered by this study which deals with the localisation of emission reductions. The emissions are essentially reduced in Europe in the "WWF/WI" scenario, whereas the "EEA nuclear" scenario anticipates that nearly half of the reductions required to achieve the presumed objective of a reduction of 40% by 2030 would be obtained by deploying the flexibility mechanisms contained in the Kyoto Protocol, which allow emission credits to be obtained for projects carried out in other countries.

[19] Energy demand per unit GDP.

[20] or: for the manufacturing sectoron average 1.6% of value added (with costs that differ between sub-sectors); for tertiary: 0.2% of value added; for households: between ¾10 and ¾20 per household in relation to a rise in energy costs, in the reference scenario, of ¾1,900/household for the EU-15 by 2030.

7. Effects anticipated by the players in the 11 Member States studied

The results presented in this section are based both on interviews with the players and on existing studies. They do not include results specifically concerning employment in the four sectors studied, which are treated in the sections devoted to the sectors.

7.1. A lack of analysis on the fallout for employment on climate policies

Overall, studies analysing the link between climate policies and employment in the Member States of the sample are rare. They are more frequent in countries which have adopted an active emissions reduction policy, such as Germany. In most cases, they limit themselves to quantitative estimation of the jobs created and destroyed, and only explore very slightly aspects related to skills or to job quality.

In the new Member States, the interest of such analyses is not perceived because of the embryonic nature of emission control policies.

7.2. Differing levels of knowledge and of involvement of union organisations

The interest and level of knowledge of union players on policies to counteract climate change differ appreciably in old and new Member States.

In the new Member States studied, except for Slovenia, players in the unions have a lower level of knowledge of questions relating to climate policies. They have little involvement in the consultation process accompanying the development of national allocation plans. By contrast, the unions in Slovenia have had discussions with the government and employer organisations about the social and employment consequences that could result from the application of the Kyoto protocol.

If the absence of a real issue for employment at this stage may explain the absence of involvement, one may nevertheless fear that the lack of expertise in union organisations on these questions will lead to a risk of weak representation of their interests when climate-policy measures become more restrictive.

In the EU-15 countries, union organisations have a generally better-developed level of knowledge and expertise. In a certain number of countries, they are directly involved in tripartite dialogues, with governments and employer organisations, on the implementation of the Kyoto protocol, or in national and regional debates on long-term emission-reduction scenarios.

7.3. The expected effect on employment depends on the ambitiousness and the effectiveness of the instruments and policies in place

In the new Member States of the EU, the reduction targets are easy to achieve and there are practically no measures to counteract climate change. As a result, the direct effects on employment are not very perceptible or predictable. However, fears are expressed about the effects of the increase of the cost of energy on the competitiveness of highly energy-consuming industries and the associated jobs.

In a similar way, in almost all Member States studied, industrial sectors exposed to international competition, such as iron and steel, have been allocated comfortable emission quotas in the national allocation plans covering the period 2005-2007, for fear of negative effects on the competitiveness of the sector. At the date of the interviews, the NAPs for the second period (2008-2012) were still in preparation and it was still too soon to judge how tight they were.

In the older Member States, there is a complex armoury of emission reduction policies and measures, which induce a broad range of predictable effects on employment, negative or positive, significant or limited. In the countries which have carried out emission reductions, such as Germany, preoccupations about the effects on the competitiveness of the sectors are more in evidence.

7.4. The overall impact on employment of policies to counter climate change compared with reference scenarios

In none of the Member States in the sample could a recent study be found which examined the total net impact on employment of the totality of emission reduction policies and measures currently being applied. However, old studies are available, as were studies examining the impact of a single policy instrument (eco-tax).

A German study by Scheelhaase et al[21] reaches the conclusion that the impact on employment of emission reduction policies and measures would be positive. The study foresees the creation of 194,000 additional man-years by 2020, on the hypothesis of a reduction in CO_2 emissions of 25% to 2005 and of 40% to 2020. The positive effects for employment will take place in the construction and renovation sectors, and in the efficiency equipment industry.

A macroeconomic study estimating the impact of the German eco-tax (additional tax on fuel and electricity) on employment reaches the same conclusion: 250,000 jobs are said to have been created since 1999 thanks to the reduced costs of work (the revenue from the taxes is used to reduce employers' welfare contributions). Compared with the reference scenario, the green tax is responsible for an increase in employment of 0.7% up to 2003, and should lead to a total increase in employment of 0.46% by 2010[22].

On the other hand, Italian studies[23] seem to show that employment could be negatively affected if Italy had to make major financial efforts to acquire emission permits allowing it to achieve its Kyoto targets in 2008-2012. This explained by a significant gap in relation to the Kyoto targets at the present time and by electricity generation that is intensive in emissions because of major use of petroleum and refusal to use nuclear energy.

Generally, the players questioned perceive the total potential impact on employment of greenhouse-gas-emission-reduction measures as minor (Spain, Czech Republic) and rather as positive (Germany).

Taking account of the regular reduction of employment in the sectors based on fossil fuels (thermal generation of electricity, manufacturing), the substitution of low-carbon activities, in particular renewable energies, should produce, in the short term, an advantage in terms of total employment. In the medium and long term, on the other hand, improvements in efficiency and the automation of industrial processes in new branches should lead to productivity gains and reduce the net benefit in terms of jobs.

[21] Prognos, 2000.

[22] Kohlhaas, 2005; Schleich et al, 2006.
[23] Institut Bruno Leoni, 2003.

7.5. The overall impact of CO_2 reductions on employment

Taking account of the high levels of unemployment experienced by most of the Member States in the sample, the question of the contribution of climate policies to the battle against unemployment is worth asking.

In all the countries studied, the industrial sectors and electricity generation based on fossil fuels have experienced substantial job losses in the past, which explains the relatively high level of unemployment. This development is not linked directly either to emission control policies, or to environmental regulations. It is caused primarily by economic restructurings (liberalisation and privatisations), technical progress and other economic factors such as globalisation and the operation of financial markets.

These developments do not seem to be fully played out in the old Member States and, in the new Member States, significant job losses should still be take place in the future (cf. analysis of electricity generation sector).

Taking account of these other influences on employment, the positive net impact of the struggle against climate change does not necessarily mean an increase of employment in absolute terms. In the case of Germany, the analysis carried out in the framework of this report estimates that the contribution of the battle against climate change to the reduction in unemployment will be slight, if not nonexistent.

7.6. The effect on skills and job quality

The players interviewed believe in general that climate policies should contribute to increasing the demand for more and more educated and skilled workers, and reduce the number of jobs available for the least qualified workers. These are general changes in the economy, but applicable also to energy efficiency measures, to the implementation of the Kyoto protocol and, certainly, to new technological developments.

Nevertheless, a German study[24] focusing on energy-intensive industries confirms the shift towards jobs corresponding to the highest levels of education (master's equivalent) and medium levels (bachelor's degree and foremen/technicians), but finds that climate policies will not have a significant effect for jobs requiring lower qualifications.

Some players believe that jobs in the new enterprises favoured by climate policies, in particular in renewable energies and energy services, tend to be less well-paid and enjoy less secure conditions of employment than in established branches. However, this is a change which is not peculiar to these activities but which also concerns new sectors like ICT.

[24] Schleich, J. et al, 2006.

7.7. A process of structural change producing winners and losers

Nevertheless, the process of greenhouse-gas emissions appears as a process of “structural change” which will create winners and losers among economic activities, with consequential effects on employment. The comparison is made with other processes of structural change, for example that linked with the spread of ICT.

One can’t talk about a “winning” or “losing” sector, but rather about opportunities and risks created by climate policies in each sector which will lead to a redistribution of the added value of the sector between the economic players depending on their strategies and their ability to manage the opportunities and risks. A good example is the development of renewable energies, the added value of which is being captured more and more by existing industrial-scale enterprises present in the equipment manufacturing sector.

Part III

Sectoral effects of CO_2 emission reduction measures

1. The electricity generation sector in Europe

1.1. Current trends: emissions, electricity generation and investments

Emissions

The electricity generation sector contributes significantly to greenhouse gas emission at the European level. As at the end of 2004, greenhouse gas emissions from the sector represented 24% of the total emissions of the 15-member EU. Over the period 1999-2004, these emissions increased by 6%. The amount of greenhouse gases emitted by the electricity sector is related to the level of fossil fuels in the mix (54% in 2004).

Generation

The growth in electricity generation has been constant over the period studied, with an average increase of 2.2% per annum. All energy branches (renewable or otherwise) have been involved in this growth, apart from hydroelectric production, which fluctuates with rainfall.

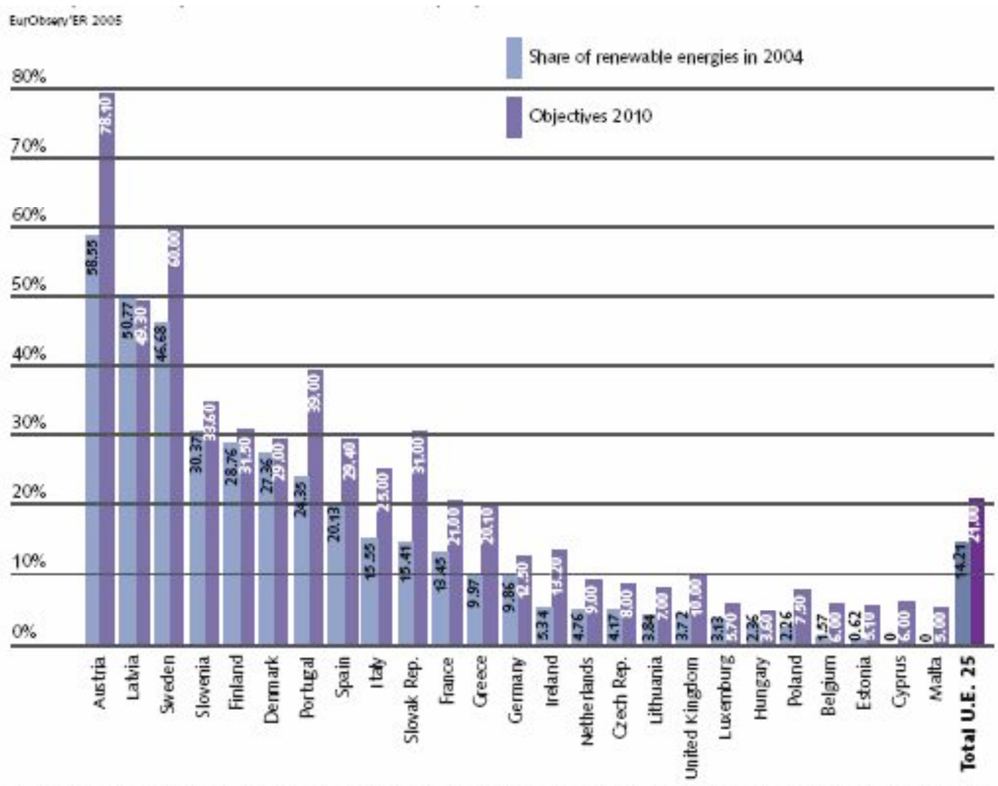
The growth of the various renewable energy sources (except hydraulic) has been very dynamic since 1994. The wind sector has experienced growth of 34.7% per annum on average; biomass electricity, helped along by the development of cogeneration in the countries of Northern Europe, grew by 11.9% per year on average. The growing incentives for solar electricity in the main countries of the Union should allow it to pursue its very high growth rate (+30.7% per annum on average).

However, the growth of renewable energy over the period 1994/2004 should not obscure the stagnation of its relative importance. The European rate in 2004 rose to 14.4%, a slight increase compared with 2003. Overall, the trend in the development of this ratio is one of stagnation, for in 1997 (the year the White Book on the development of renewable branches was published) the share was 13.9%. The European target of 21% in 2010 for member countries as a whole is thus a bit further off. Among the totality of European Union countries, only four are currently close to their targets for 2010 (Latvia, Slovenia, Finland and Denmark).

Table II.1. and fig. III.1.: Share of renewable energy sources in gross energy consumption in EU countries in 2004 (in %)

Production électrique par source / *Electric production by source*

TWh	1994	2001	2002	2003	2004	TCAM/*AAGR* 94/04	TC/*GR* 03/04
Géothermie/*Geothermal*	3,5	4,6	4,8	5,5	5,5	4,9 %	1,6 %
Éolien/*Wind*	2,9	26,8	36,4	44,4	56,8	34,7 %	27,9 %
Biom. et déchets/*Biom. and wastes*	27,1	52,0	58,8	64,2	75,6	10,8 %	17,7 %
(dont biomasse) *(biomass share)*	*19,1*	*36,8*	*43,3*	*48,1*	*58,7*	*11,9 %*	*22,1 %*
Solaire/*Solar*	0,045	0,207	0,298	0,475	0,650	30,7 %	36,9 %
Hydraulique/*Hydraulic*	331,0	384,2	328,5	323,9	334,8	0,1 %	3,3 %
(dont turb. pomp.) *(pump storage share)*	*18,1*	*28,8*	*32,0*	*31,8*	*33,3*	*6,3 %*	*4,6 %*
Nucléaire/*Nuclear*	842,9	954,0	964,5	973,7	987,2	1,6 %	1,4 %
Fossile/*Fossil*	1354,4	1585,6	1626,1	1704,0	1709,8	2,4 %	0,3 %
Tot. renouvelable/*renewable*	**356,4**	**452,7**	**413,3**	**422,4**	**456,5**	**2,5 %**	**8,1 %**
Tot. conventionnel/*conventional*	**2205,3**	**2554,7**	**2606,0**	**2693,8**	**2713,8**	**2,1%**	**0,7 %**
Total production	**2561,8**	**3007,4**	**3019,3**	**3116,2**	**3170,3**	**2,2 %**	**1,7 %**
Part renouvelable/Renew. share	***13,9 %***	***15,1 %***	***13,7 %***	***13,6 %***	***14,4 %***		



Source: Observ'ER

Table III.2.: Electricity capacities connected to the grid in 2005 in Western Europe
Power en Europe (PLATTS) : index of new projects (January 2006)

	Energy / technology										
Country	gas	wind	coke	hydro	nuclear	biomass	solar	fuel	waste	total	% total
Spain	5 200									5 200	32%
Italy	4 928		100	158				210		5 396	33%
UK	400									400	2%
Germany	1 947					77				2 024	12%
France	1 056	30								1 086	7%
total five	13 531	30	100	158	0	77	0	210	0	14 106	87%
Netherlands										0	0%
Sweden										0	0%
Greece				162						162	1%
Portugal	800			192						992	6%
Norway		150		56						206	1%
Austria										0	0%
Switzerland										0	0%
Belgium	385									385	2%
Cyprus										0	0%
Ireland		95				250				345	2%
Finland										0	0%
Denmark										0	0%
Iceland										0	0%
Total others Europe	1 185	245	0	410	0	250	0	0	0	2 090	13%
Total	14 716									16 196	100%
% total	91%	2%	1%	4%	0%	2%	0%	1%	0%	100%	

Table III.3.: Projects of power stations under construction in Western Europe
Power in Europe (Platts): index of new projects (april 2006)

	Energy / technology										
Country	gas	wind	coke	hydro	nuclear	biomass	solar	geotherm ics	waste	total	% total
Spain	9 955		1 400							11 355	27%
Italy	13 562									13 562	32%
UK		280	130							410	1%
Germany	4 400	471	2 130			20				7 021	17%
France	1 300	40			1 600					2 940	7%
total five	29 217	791	3 660	0	1 600	20	0		0	35 288	83%
Netherlands		219								219	1%
Sweden	260				132					392	1%
Greece				162						162	0%
Portugal	400									400	1%
Norway	420	40		235						695	2%
Austria				585		62				647	2%
Switzerland										0	0%
Belgium	120	490								610	1%
Cyprus	900									900	2%
Ireland	550									550	1%
Finland	100				1 600					1 700	4%
Denmark										0	0%
Iceland				690				100		790	2%
Total others Europe	2 750	749	0	1 672	1 732	62	0	100	0	7 065	17%
Total	31 967	1 540	3 660	1 672	3 332	82	0	100	0	42 353	100%
% total	75%	4%	9%	4%	8%	0%	0%	0%	0%	100%	

1.2. A resumption of construction of electric power stations in Europe[25], which stabilises employment with energy producers at the 2010 horizon and produces an increase in indirect employment (equipment suppliers, services)

Commissioning of new power stations resumes in Western Europe

After relatively weak years in 2002 and 2003, power station commissionings increased again in 2004, a tendency confirmed in 2005. Whereas wind power had been the driving force in Germany, Scandinavia and Spain, 90% of new stations currently being connected to the grid use gas in a combined cycle with a steam turbine.

The large volume of electrical generating capacity currently under construction should further increase the rate at which capacity is brought on stream.

The stations currently under construction represent two and a half years of commissioning at 2005 rates, which suggests an increase in the rate of commissioning.

In fact, it takes barely more than 2 years to build a gas power station. In the same way, the commissioning of a wind farm is achieved within 2 to 3 years. On the other hand, a coal-fired station requires 4 to 5 years, or even longer, if it provides for CO_2 capture. Finally the Flamandville EPR nuclear power station should go into production in 2012.

Given these construction times, the high preponderance of gas (3/4) in projects under construction should lead to a higher share of this form of energy in commissionings in the coming years.

Far from slowing down, new power station projects are plentiful: 130MW

By comparison with the start of 2005, new capacity in construction projects has increased by 28%.

This growth is largely caused by the resurgence of coal among power station projects, initially in Germany, but then also in Holland and Great Britain. In these three countries it is primarily German operators (RWE and EON) or their subsidiaries that take part in projects around this form of energy.

We note that several projects provide for the capture of the carbon dioxide produced by combustion. The English projects close to the North Sea even expect to make a profit from this CO_2, because by being injected into gas fields, it would prolong their productive life by 20 years. The emergence of projects around coal coincides quite logically with the hike in gas prices and with the continual inflation of European pollution taxes.

On the other hand, we observe a gap between the magnitude of wind generation projects, often supported by the state, and the small size of those actually under construction. This reflects very different dynamics between the first wind-powered countries and the others:

German, Scandinavian and Spanish wind farms are reaching an initial level of saturation on the ground and are oriented largely towards "offshore" wind power, i.e. in the sea, which brings some additional delays;

[25] Source: Syndex – JG Defrance – April 2006.

The United Kingdom and even more so France are having trouble finding investors interested in the possible projects offered by their administrations. With the many wind power projects unable to attract investors, the growing need for electricity is currently being covered by new gas-fired stations.

Italy and Spain invest almost exclusively in gas; this form of energy continues to constitute the great majority of projected electrical generating capacity.

Generally speaking, projects launched into construction in Europe are “replaced” or even overtaken by new more numerous projects or projects representing greater capacities.

Table III.4. : Western Europe : projects of power stations without equipment providers - Power in Europe (PLATTS), index of new projects (april 2006)

	Energy / technology										
Country	gas	wind	coke	hydro	nuclear	biomass	solar	geotherm ics	waste	total	% total
Spain	26 550	1 000	0	630			50			28 230	22%
Italy	18 216		1 980							20 196	16%
UK	10 820	8 770	3 030	100		30			72	22 822	18%
Germany	4 425	2 673	10 960	45						18 103	14%
France	3 640	588	700	90	2 100	250				7 368	6%
total five	63 651	13 031	16 670	865	2 100	280	50	0	72	96 719	75%
Netherlands	3 480		3 000			450				6 930	5%
Sweden	400	3 880			726					5 006	4%
Greece	3 693	95		246						4 034	3%
Portugal	2 875	1 500		170			62			4 607	4%
Norway	1 945	2 164								4 109	3%
Austria	1 570		800	480						2 850	2%
Switzerland	370			1 460						1 830	1%
Belgium	1 370	216								1 586	1%
Cyprus										0	2%
Ireland	400	300								700	1%
Finland		350		44		200				594	0%
Denmark		400				32				432	0%
Iceland								80		80	0%
Total others Europe	16 103	8 905	3 800	2 400	726	682	62	80	0	32 758	25%
Total	79 754	21 936	20 470	3 265	2 826	962	112	80	72	129 477	100%
% total	62%	17%	16%	3%	2%	1%	0%	0%	0%	100%	

1.3. The lessons of the scenarios for the dynamics of employment on the 2012-2030 horizon

The scenarios and their characteristics

The scenarios examined include the three base scenarios described in 2.2 (reference scenario, WWF/WI scenario and AEE-nuclear scenario) as well as an additional alternative scenario entitled "Factor 4", accompanied by its reference scenario, developed by the French DGEMP[26]. The "Factor 4" scenario uses the POLES, MEDEE and VLEEM models, and relates to the 2050 time-horizon.

The fundamental elements that distinguish them for the electricity-generating sector are the following:

In the first place, the WWF/WI, AEE-nuclear and still more Factor 4 (F4) scenarios fall within the ambit of active and ambitious greenhouse-gas-reduction strategies: -2.15% CO_2 emissions on average for the EEA-nuclear scenario for the period 2000/2030, -3.09% for the WWF/WI scenario over the period 2000/2020 and -4,4% on average per annum for the F4 scenario over the period 2001/2030 for the EU 15.

Secondly, the reduction of CO_2 emissions comes in part from energy efficiency which leads to a reduction in demand from energy-consuming sectors: residential and manufacturing notably, testimony to the uncoupling of the rate of growth in electricity production from that of GDP growth, especially for the P&M and F4 scenarios. More so the latter, which registers a 0.24% decrease in electricity production on average over the period 2001/2030 against a 2.3% growth in GDP.

The slowdown in demand from the electricity-consuming sectors is conjugated according to the scenarios with a strong differentiation in the technological mix when it comes to generation. Renewable energy for the WWF/WI scenario (40% of electricity production with an horizon of 2020 for the EU 25), nuclear for the F4 scenario (46% of electricity production at the 2030 horizon at the EU 15 level) and nuclear/gas for the EEA scenario: 30% for nuclear and 38% for gas as against 21% and 44% respectively for the BAU scenario.

For its part, scenario F4 explores the alternatives at the 2050 horizon: sequestration and hydrogen, which from our point of view represent a major issue for Europe both in industrial terms and in terms of sustainable development of national electricity generation systems given the strong differentiation existing within Europe.

Method for calculating jobs generated by branches of electricity generation

For lack of an inter-industry exchange model on one hand and of sufficiently detailed employment statistics on the other, we tried to take account of the employment dynamics underlying each of the scenarios by relying on works taking account of jobs generated by each of the branches of electricity generation.

The report of Christian Bataille and Robert Galley[27], from February 1994, casts some light on the jobs generated by each of the non-renewable technologies. Considering investment (R&D and construction), operation (and maintenance) and fuel (upstream in the cycle), Bataille and Galley estimate the job-intensity of the nuclear branch at 180 jobs per TWh/yr, as against 105-120 for gas and 165 for coal. The evaluations were used as a reference in the study conducted by Antoine Bonduelle[28]. In regard to renewable energy sources we have considered several sources, and

[26] "Etude pour une prospective énergétique concernant la France", Observatoire de l'Energie et Direction Générale de l'Energie et des Matières Premières, February 2005.

[27] Bataille C., Galley R., 1999. *L'aval du cycle nucléaire. Volume II: Les coûts de production de l'électricité*, Rapport n° 1359, Sénat, 3 February.

[28] Eole ou pluton "2003", report commissioned by Greenpeace.

in particular the work of Kammen, Kapadia & Fripp[29].

Secondly, we have calculated an average "renewable energy" ratio based on the average mix emerging from the MITRE and WWF/WI studies, viz: 35% wind, 25% photovoltaic, 21% biomass and 19% hydraulic.

Table III.5.: Jobs generated by branches of electricity generation

FTE/Twhan	Exploitation and maintenance	Exploitation and maintenance, fuel R&D, building FTE	
Nuclear	105	180	Bataille
Coke	110	165	Bataille
Gas	80	110	Bataille
Hydraulics			
EnR	66	316	
Photo FTE/GWh	0,14	0,66	Berkeley / Green Peace
Waste FTE/GWh	0,03	0,32	Berkeley / Green Peace
biomass	0,04	0,05	
EnR FTE/Gwh			Mitre
ENR FTE/Twh	0,125	500	Krewitt

Impact on employment dynamics

The evaluations carried out on the basis of these job-intensities by technological branch allow us to grasp the issues linked to the development of the electricity generation sector, in terms both of jobs linked to operations and maintenance (directly or indirectly) and of jobs generated by infrastructure investments.

The impact on employment linked to operation and maintenance

The first lesson which emerges from this evaluative exercise relates to changes in overall employment linked to operation and maintenance.

The drop in electricity consumption by comparison with the reference scenario translates to an appreciable slow-down in the growth in electricity production, as an effect of the reduction in energy-intensity, translated in fact by a gap of more than 80,000 FTE jobs in 2030 for scenario F4, 65,000 FTE jobs in 2020 for the WWF/WI scenario, and 15,000 FTE jobs in 2030 for the AEE-nuclear scenario.

Thus, unlike the reference scenario, which anticipates employment growth of 1% per year, employment would remain stable for the WWF/WI and EEA-nuclear scenarios, even slightly decreasing for the WWF/WI over the period 2000-2020. Only scenario F4 breaks from this, with an annual reduction in employment of 0.35% over the period 2001/2030.

The F4 scenario, the most ambitious from this point of view with an average decrease in activity of 0,24% against a GDP increase of +2,3%, nevertheless shows that the drop in employment remains relatively low (-0.17% in 2010 and – 0.35% in 2030).

Thus the WWF/WI scenario and still more F4 confirm the sensitivity of employment to changes in energy efficiency of energy consumers.

The second lesson concerns the changes by energy type.

The evolutions described above evolve along strongly differentiated courses by energy type according to the scenario used:

- An increase in jobs from gas and for renewable energies for all scenarios except F4 for gas over the period 2001-2030;
- An appreciable decrease in jobs from coal over the same period (by a factor of around three). Scenario F4, for its part, formulates the hypothesis of an upward movement in employment to the 2050 horizon as an effect of the maturing of CO_2 sequestration technology;
- A decrease in those jobs arising from nuclear energy, apart from the EEA-nuclear and F4 scenarios.

[29] Kammen, Kapadia & Fripp, Putting renewables to work: how many jobs can the clean energy industry generate? Berkeley, April 13 2004

These results confirm major changes in the structure of direct and indirect jobs, and raise the question of the means to be deployed to ensure the job mobility of the affected employees.

Depending on the current structure of the energy mix, the impact of the change of energy mix will vary vastly in magnitude from one EU country to another. Through the cases of Belgium and Germany, we will try to clarify the question posed by nuclear exit in the framework an active policy of fighting climate change.

The impact on employment linked to investments

The second result concerns the changes in overall employment generated by infrastructure investments (equipment suppliers, construction, installation).

- The jobs generated by investment are, in all scenarios, animated by a dynamic of relatively sustained growth over the period 2001-2030.
- This growth is greater than that predicted by the reference scenario in the WWF/WI and AEE-nuclear scenarios, the gap being 80,000 and 50,000 FTE jobs respectively.

The second result concerns jobs generated by energy type.

- Over the period 2001-2030, jobs related to the renewable energy branch underwent strong growth, between +5,85% for WWF/WI and +1,4% for F4. This growth is greater than that predicted by the reference scenario, by about 90,000 FTE jobs for the WWF/WI scenario and 55,000 jobs for the AEE-nuclear scenario.
- Over the period 2001-2030, jobs in the gas branch move positively for all scenarios except F4 (-1.07%), although at a slower rate than in the reference scenario (deficit between 10,000 and 30,000 FTE jobs).
- Contrariwise, jobs produced by the nuclear and coal branches register a drop except for the EEA-nuclear and F4 scenarios.

Balance of employment movements in the electricity generation sector

Over the period considered, overall employment, including the induced effects linked to investments, advances noticeably:. Taking account of job losses linked to production and maintenance, the equipment supply industry benefits greatly.

Thus, far from being unfavourable to employment, active and ambitious energy-intensity reduction policies make a positive contribution to employment despite leading to a slight erosion of employment in the electricity generation sector (WWF/WI and F4). By contrast, manufacturing is reinforced and records an increase in jobs, which raises real questions about industry policy in coherence with the goals of greenhouse gas reduction.

Table III.6 : Synthetic presentation of the scenarios

	BAU				P&M Wuppertal			EEA LCEP		
UE 25	2000	2010	2020	2030	2000	2010	2020	2000	Baseline 2030	Nuclear Accelerated
Electricity genration TWh	2 898	3 400	3 950	4 397	2 898	3 200	3 300	2 898	4 397	4 271
Nuclear	921,6	952,0	837,4	800,3	921,6	960,0	792,0	921,6	800,3	1 259,9
Solid	912,9	618,8	501,7	659,6	912,9	608,0	264,0	912,9	659,6	226,4
Oil	173,9	81,6	55,3	35,2	173,9	64,0	0,0	173,9	35,2	0,0
Gas	466,6	1 111,8	1 738,0	1 934,7	466,6	928,0	924,0	466,6	1 934,7	1 614,4
Biomass-waste	58,0	102,0	150,1	175,9	58,0	96,0	462,0	58,0	175,9	85,4
Hydro and other renewables	342,0	357,0	383,2	413,3	342,0	384,0	495,0	342,0	413,3	597,9
Wind	23,2	176,8	284,4	378,1	23,2	160,0	363,0	23,2	378,1	486,9
Mt CO2	1 228,0	1 235,0	1 403,0	1 613,0	1 228,0	1 078,0	656,0	1 228,0	1 613,0	640,0
Annual Growth rate (%)		0,06%	0,67%	0,91%		-1,29%	-3,09%		0,91%	-2,15%
Carbon intensity TCO2/MWh	0,42	0,36	0,36	0,37	0,42	0,34	0,20	0,42	0,37	0,15
GDP (in 000 Euro'00)	8939	11433	14462	18020	8939	11433	14462			
GDP Growth rate %		2,49%	2,43%	1,53%		2,77%	2,43%			
Electricity generation TWh Growth rate		1,61%	1,56%	1,40%		1,00%	0,65%		1,40%	1,30%
Nuclear		0,33%	-0,48%	-0,47%		0,41%	-0,75%		-0,47%	1,05%
Solid		-3,81%	-2,95%	-1,08%		-3,98%	-6,01%		-1,08%	-4,54%
Oil		-7,29%	-5,57%	-5,19%		-9,51%	-100,00%		-5,19%	-100,00%
Gas		9,07%	6,80%	4,86%		7,12%	3,48%		4,86%	4,22%
Biomass-waste		5,81%	4,87%	3,77%		5,18%	10,94%		3,77%	1,30%
Hydro and other renewables		0,43%	0,57%	0,63%		1,17%	1,87%		0,63%	1,88%
Wind		22,53%	13,35%	9,75%		21,31%	14,75%		9,75%	10,68%

	UE15 BAU			F4 UE 15			F4 UE 15 2050		
UE 25	2000	2010	2030	2001	2010	2030	Baseline	Séque-stration	Hydrogen
Electricity genration TWh	2 574	3 007	3 530	2 574	2 594	2 400	2 300	2 300	2 300
Nuclear	864,0	894,0	745,0	864,0	864,0	1 100,0	1 400,0	842,5	1 102,2
Solid	772,2	496,2	420,1	772,2	630,0	320,0	50,0	544,0	
Oil	128,7	60,1	35,3	128,7	100,0	80,0			
Gas	414,4	983,3	1 553,2	414,4	500,0	300,0	250,0	270,0	403,8
Biomass-waste	51,5	90,2	134,1	51,5					
Hydro and other renewables	344,0	483,0	643,0	344,0	500,0	600,0	600,0	643,3	794,0
Wind									
Mt CO2	948,0	951,9	1 280,5	948,0	900,0	400,0			
Annual Growth rate (%)		0,04%	1,51%		-0,58%	-4,44%			
Carbon intensity TCO2/MWh	0,37	0,32	0,36	0,37	0,35	0,17			
GDP (in 000 Euro'00)	8545	10859	16920						
GDP Growth rate %		2,43%	2,30%		2,3%	2,3%		2,3%	2,3%
Electricity generation TWh Growth rate		1,57%	1,06%		0,09%	-0,24%	-0,23%	-0,23%	-0,23%
Nuclear		0,34%	-0,49%		0,00%	0,81%	0,97%	-0,05%	0,49%
Solid		-4,33%	-2,01%		-2,01%	-2,89%	-5,33%	-0,70%	-100,00%
Oil		-7,33%	-4,22%		-2,49%	-1,57%	-100,00%	-100,00%	-100,00%
Gas		9,02%	4,50%		1,90%	-1,07%	-1,01%	-0,85%	-0,05%
Biomass-waste		5,77%	3,24%				-100,00%	-100,00%	-100,00%
Hydro and other renewables		3,45%	2,11%		3,81%	1,87%	1,12%	1,26%	1,69%
Wind									

Fig. III.2: Synthetic presentation of the scenarios

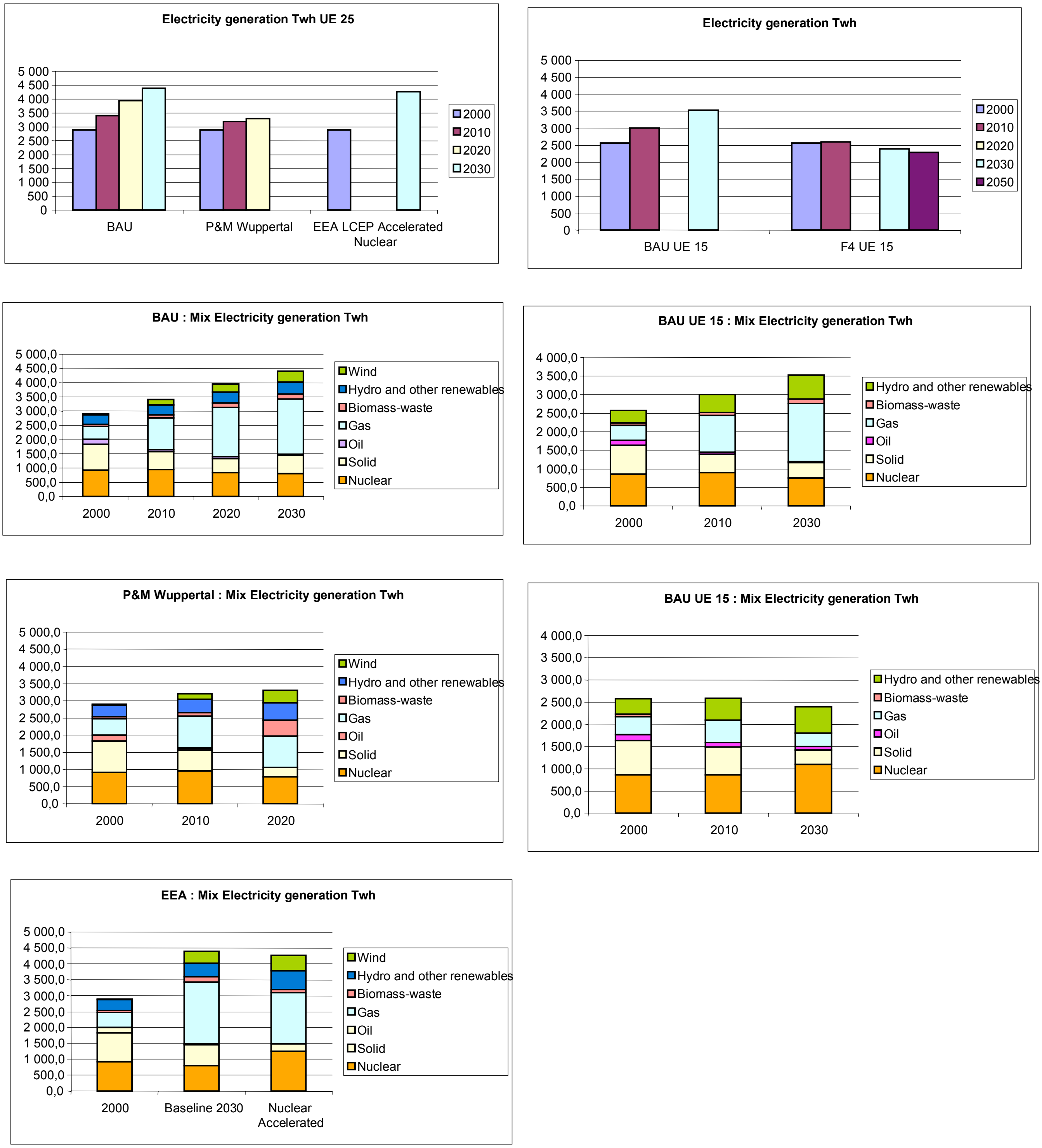


Table. III.7: Dynamics of direct employment in the electricity generation sector in Europe

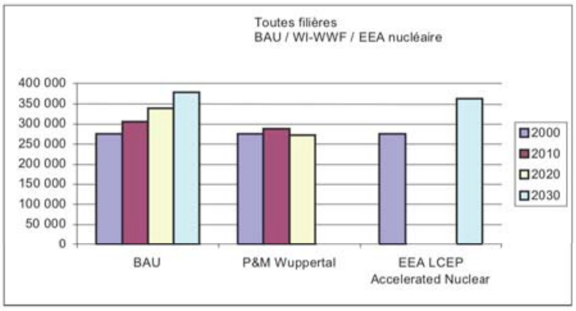
O&M and fuel processing	BAU				WWF/ WI			EEA Nuclear		
EU 25	2000	2010	2020	2030	2000	2010	2020	2000	Baseline 2030	Nuclear Accelerated
FTE	276 342	305 463	340 537	378 010	276 342	289 280	273 240	276 342	378 010	363 586
Nuclear	96 764,2	99 960,0	87 927,0	84 026,7	96 764,2	100 800,0	83 160,0	96 764,2	84 026,7	132 294,2
Solid	100 415,7	68 068,0	55 181,5	72 550,5	100 415,7	66 880,0	29 040,0	100 415,7	72 550,5	24 899,9
Oil	13 910,4	6 528,0	4 424,0	2 814,1	13 910,4	5 120,0	0,0	13 910,4	2 814,1	0,0
Gaz	37 326,2	88 944,0	139 040,0	154 774,4	37 326,2	74 240,0	73 920,0	37 326,2	154 774,4	129 155,0
Biomass - waste Hydro and other renewables Wind	27 925,1	41 962,8	53 964,9	63 844,4	27 925,1	42 240,0	87 120,0	27 925,1	63 844,4	77 236,8

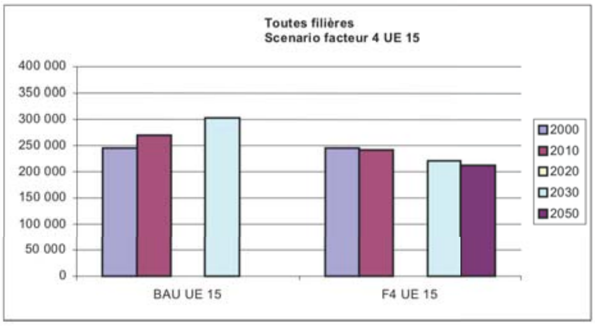
Electricity generation TWh growth rate		1,61%	1,56%	1,40%		1,00%	0,65%		1,40%	1,30%
FTE		1,01%	1,05%	1,05%		0,46%	-0,06%		1,05%	0,92%
Nuclear		0,33%	-0,48%	-0,47%		0,41%	-0,75%		-0,47%	1,05%
Solid		-3,81%	-2,95%	-1,08%		-3,98%	-6,01%		-1,08%	-4,54%
Oil		-7,29%	-5,57%	-5,19%		-9,51%	-100,00%		-5,19%	-100,00%
Gas		9,07%	6,80%	4,86%		7,12%	3,48%		4,86%	4,22%
Biomass - waste										
Hydro and other renewables		4,16%	3,35%	2,79%		4,23%	5,85%		2,79%	3,45%

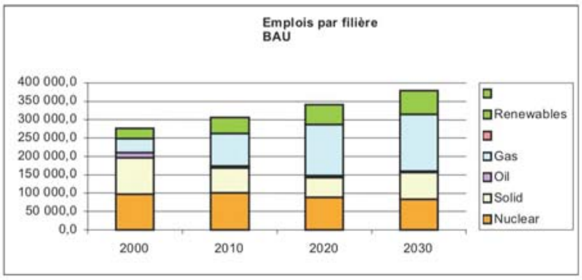
O&M and fuel processing	UE15 BAU			F4 UE 15			F4 UE 15 2050		
EU 25	2000	2010	2030	2001	2010	2030	Baseline	Sequestrati on	Hydrogen
FTE	245 213	269 753	302 804	245 213	241 020	220 700	212 100	212 360	200 439
Nuclear	90 720,0	93 870,0	78 225,0	90 720,0	90 720,0	115 500,0	147 000,0	88 462,5	115 731,0
Solid	84 942,0	54 577,1	46 207,7	84 942,0	69 300,0	35 200,0	5 500,0	59 840,0	0,0
Oil	10 296,0	4 811,2	2 824,0	10 296,0	8 000,0	6 400,0	0,0	0,0	0,0
Gaz	33 153,1	78 663,1	124 256,0	33 153,1	40 000,0	24 000,0	20 000,0	21 600,0	32 304,0
Biomass - waste Hydro and other renewables Wind	26 101,7	37 831,9	51 291,2	26 101,7	33 000,0	39 600,0	39 600,0	42 457,8	52 404,0

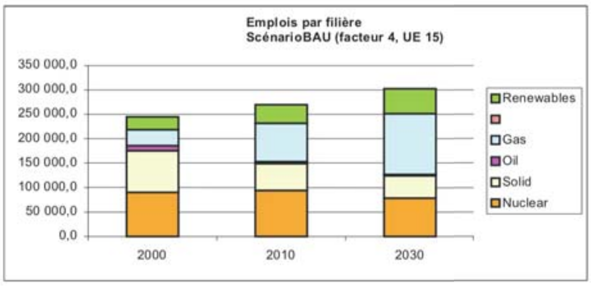
Electricity generation TWh growth rate		1,57%	1,06%		0,09%	-0,24%	-0,23%	-0,23%	-0,23%
FTE		0,96%	0,71%		-0,17%	-0,35%	-0,29%	-0,29%	-0,40%
Nuclear		0,34%	-0,49%		0,00%	0,81%	0,97%	-0,05%	0,49%
Solid		-4,33%	-2,01%		-2,01%	-2,89%	-5,33%	-0,70%	-100,00%
Oil		-7,33%	-4,22%		-2,49%	-1,57%	-100,00%	-100,00%	-100,00%
Gas		9,02%	4,50%		1,90%	-1,07%	-1,01%	-0,85%	-0,05%
Biomass - waste									
Hydro and other renewables		3,78%	2,28%		2,37%	1,40%	0,84%	0,98%	1,40%

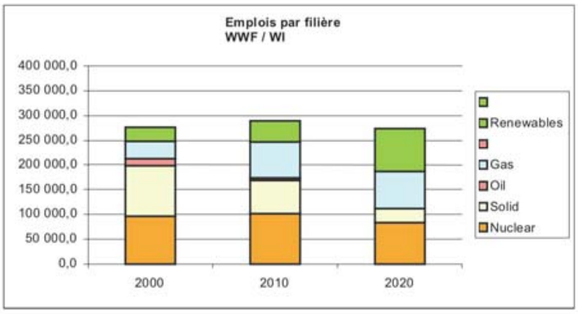
Fig. III.3. Dynamics of the direct and indirect employment in the sector of the production of electricity in Europe

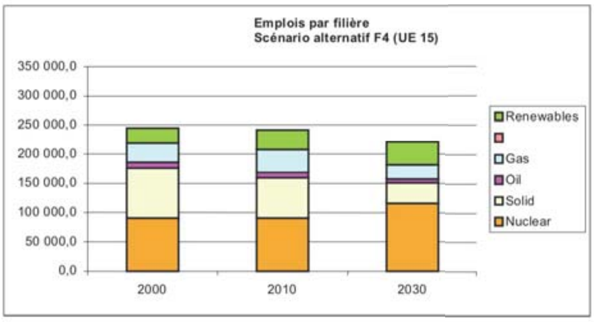












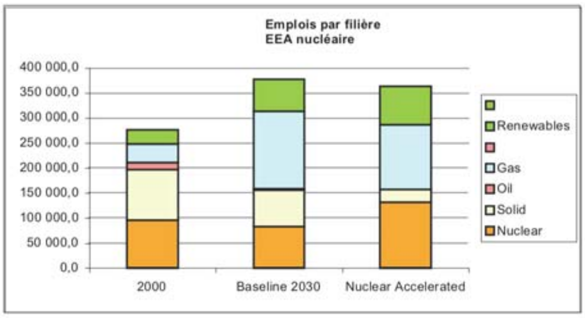


Table. III.8. Dynamics of the led employment (investments) in the sector of the production of electricity in Europe

Construction, manufacturing, installation	BAU				P&M Wuppertal			EEA LCEP		
									Baseline	Nuclear
UE 25	2000	2010	2020	2030	2000	2010	2020	2000	2030	Accelerated
FTE	244 316	300 186	348 607	397 225	244 316	295 200	431 640	244 316	397 225	447 942
Nuclear	69 117,3	71 400,0	62 805,0	60 019,1	69 117,3	72 000,0	59 400,0	69 117,3	60 019,1	94 495,9
Solid	50 207,9	34 034,0	27 590,8	36 275,3	50 207,9	33 440,0	14 520,0	50 207,9	36 275,3	12 450,0
Oil	5 216,4	2 448,0	1 659,0	1 055,3	5 216,4	1 920,0	0,0	5 216,4	1 055,3	0,0
Gas	13 997,3	33 354,0	52 140,0	58 040,4	13 997,3	27 840,0	27 720,0	13 997,3	58 040,4	48 433,1
Biomass-waste										
Hydro and other renewables	105 777,0	158 950,0	204 412,5	241 835,0	105 777,0	160 000,0	330 000,0	105 777,0	241 835,0	292 563,5
Wind										
			697 215							

Taux de croissance de la production d'électricité (en tWh)		1,61%	1,56%	1,40%		1,00%	0,65%		1,40%	1,30%
FTE		2,08%	1,79%	1,63%		1,91%	2,89%		1,63%	2,04%
Nuclear		0,33%	-0,48%	-0,47%		0,41%	-0,75%		-0,47%	1,05%
Solid		-3,81%	-2,95%	-1,08%		-3,98%	-6,01%		-1,08%	-4,54%
Oil		-7,29%	-5,57%	-5,19%		-9,51%	-100,00%		-5,19%	-100,00%
Gas		9,07%	6,80%	4,86%		7,12%	3,48%		4,86%	4,22%
Biomass-waste										
Hydro and other renewables		4,16%	3,35%	2,79%		4,23%	5,85%		2,79%	3,45%

Construction, manufacturing, installation	UE15 BAU			F4 UE 15			F4 UE 15 2050		
UE 25	2000	2010	2030	2001	2010	2030	Baseline	Séquestration	Hydrogen
FTE	222 434	268 944	320 919	222 434	242 450	261 500	265 250	262 033	293 279
Nuclear	64 800,0	67 050,0	55 875,0	64 800,0	64 800,0	82 500,0	105 000,0	63 187,5	82 665,0
Solid	42 471,0	27 288,5	23 103,9	42 471,0	34 650,0	17 600,0	2 750,0	29 920,0	0,0
Oil	3 861,0	1 804,2	1 059,0	3 861,0	3 000,0	2 400,0	0,0	0,0	0,0
Gas	12 432,4	29 498,7	46 596,0	12 432,4	15 000,0	9 000,0	7 500,0	8 100,0	12 114,0
Biomass-waste									
Hydro and other renewables	98 870,0	143 302,5	194 285,0	98 870,0	125 000,0	150 000,0	150 000,0	160 825,0	198 500,0
Wind									

Taux de croissance de la production d'électricité (en tWh)		1,57%	1,06%		0,09%	-0,24%	-0,23%	-0,23%	-0,23%
FTE		1,92%	1,23%		0,87%	0,54%	0,35%	0,33%	0,55%
Nuclear		0,34%	-0,49%		0,00%	0,81%	0,97%	-0,05%	0,49%
Solid		-4,33%	-2,01%		-2,01%	-2,89%	-5,33%	-0,70%	-100,00%
Oil		-7,33%	-4,22%		-2,49%	-1,57%	-100,00%	-100,00%	-100,00%
Gas		9,02%	4,50%		1,90%	-1,07%	-1,01%	-0,85%	-0,05%
Biomass-waste									
Hydro and other renewables		3,78%	2,28%		2,37%	1,40%	0,84%	0,98%	1,40%

Fig. III.4. Dynamics of the led employment (investments) in the sector of the production of electricity in Europe

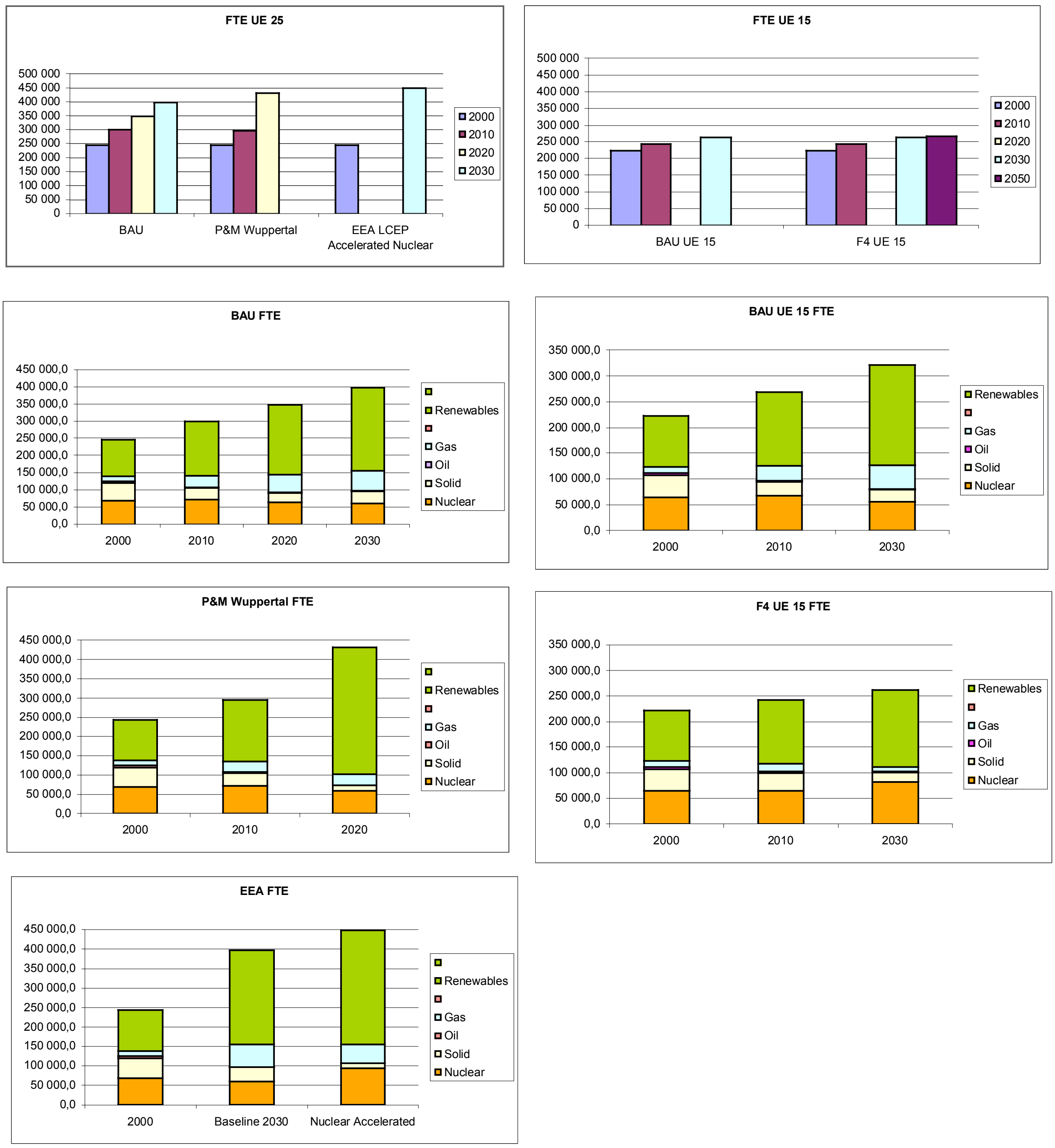


Table III.9. : Electricity generation : prospects in Belgium

EU 25	2000	2010	2020	2030
Electricity generation TWh	83	97	110	120
Nuclear	47,2	48,2	35,5	0,0
Solid condensation Coal & CHP	11,4	4,9	1,1	44,4
Oil	0,6	0,3	0,0	0,0
Gas	20,7	38,3	65,2	63,7
Biomass and waste	1,1	1,5	2,5	3,6
Hydro and other renewables	1,7	1,3	1,1	1,1
Wind	0,0	2,0	4,5	7,2
Electricity generation TWh growth rate		1,57%	1,44%	1,25%
Nuclear		0,21%	-1,41%	-100,00%
Solid condensation Coal & CHP		-8,06%	-11,03%	4,64%
Oil		-6,68%	-100,00%	-100,00%
Gas		6,38%	5,92%	3,83%
Biomass and waste		3,70%	4,38%	4,11%
Hydro and other renewables		-3,19%	-2,25%	-1,57%
Wind			8,33%	6,54%

Source : D. Gusbin et B. Hoonaert- 2004

O&M and fuel processing				
EU 25	2000	2010	2020	2030
FTE	8 090	9 004	9 607	10 766
Nuclear	4 952,3	5 056,1	3 730,7	0,0
Solid	1 253,9	541,4	121,0	4 884,0
Oil	46,3	23,2	0,0	0,0
Gas	1 652,0	3 064,8	5 218,4	5 097,6
Biomass and waste				
Hydro and other renewables	185,4	318,5	537,2	784,1
Wind				

Electricity generation TWh growth rate	1,57%	1,44%	1,25%
FTE	1,08%	0,86%	0,96%
Nuclear	0,21%	-1,41%	-100,00%
Solid	-8,06%	-11,03%	4,64%
Oil	-6,68%	-100,00%	-100,00%
Gas	6,38%	5,92%	3,83%
Biomass and waste			
Hydro and other renewables	5,56%	5,46%	4,92%

1.4. Nuclear exit and emission reductions: illustration of employment implications through the cases of Belgium and Germany

A substitution of gas and coal for nuclear at the 2030 horizon in the Belgian reference scenario

The reference scenario (BAU) describes the changes in the structure of electricity generation in Belgium from now to 2030, on the hypothesis of implementation of the law on progressive nuclear exit, but without supposing any additional policies and measures to reduce greenhouse-gas emissions.

Over the period 1990-2000, we observe a relative stability in the allocation of production between fossil and non-fossil energy sources: nuclear plants thus provide about 60% of electricity production and stations burning fossil fuels a little less than 40%. Within this second category, substitutions between fossil fuels have nevertheless taken place: the share taken by coal and petroleum products has progressively reduced in favour of natural gas (25% in 2000 as against 10% in 1990) following the commissioning of TGV stations.

The period 2000-2030 covered by the base scenario (BAU) should be marked by continued growth of the share of natural gas in electricity generation; this share would reach a maximum of 60% in 2020, or some 65,000 GWh. This growth is due to the development of combined-cycle plants and cogeneration. On the other hand, the generation of electricity of nuclear origin would see its share diminish regularly: slightly at first until reaching 50% in 2010, then significantly after this because of the programmed decommissioning of nuclear power stations.

The generation of electricity from coal would also have new prospects beyond 2020, after a significant and regular decline between 1990 and 2020 because of decommissioning and non-replacement of existing conventional thermal

Fig. III.5.: Changes in installed capacity

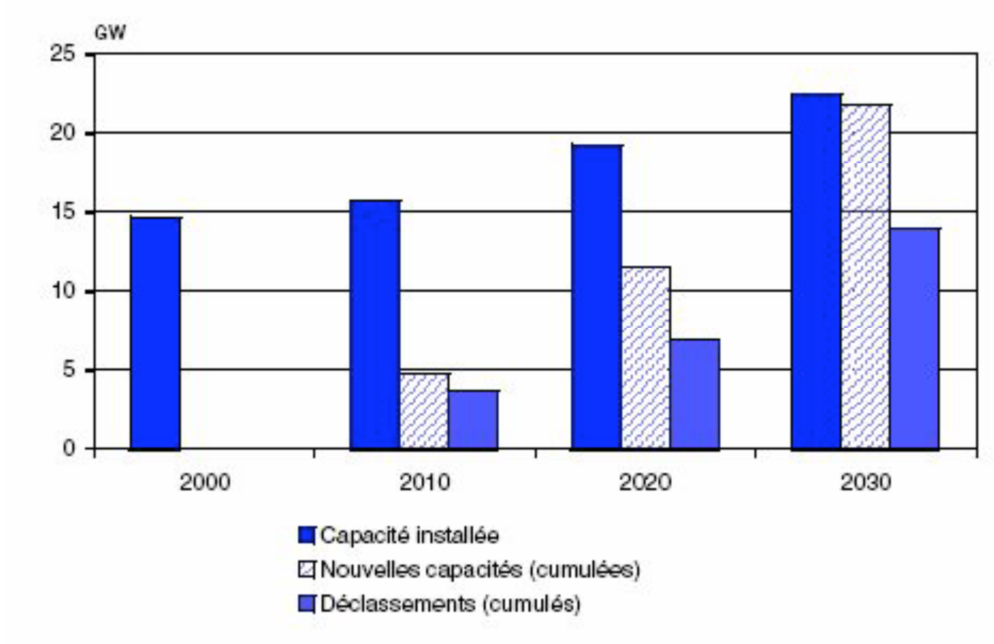


Table III.10. : Electricity generation : prospects in Germany

EU 25	2000	2010	2020	2030
Electricity generation TWh	551	520	495	475
Nuclear	160,3	98,8	22,8	0,0
Solid, condensation, charbon et CHP	308,6	295,9	288,1	229,4
Oil	0,0	0,0	0,0	0,0
Gas	28,7	30,2	45,5	53,2
Biomass and waste	0,0	7,3	30,2	30,4
hydro and other renewables	38,6	27,6	39,1	81,7
Wind	14,9	60,3	69,3	76,0
Electricity generation TWh growth rate		-0,58%	-0,53%	-0,49%
Nuclear		-4,73%	-9,30%	-100,00%
Solid		-0,42%	-0,34%	-0,98%
Oil				
Gas		0,51%	2,34%	2,08%
Biomass and waste			15,29%	7,41%
hydro and other renewables		-3,31%	0,07%	2,53%
Wind		15,03%	8,00%	5,59%

Source Wuppertal

O&M et Oil processing				
EU 25	2000	2010	2020	2030
FTE	56 597	51 614	46 872	41 907
Nuclear	16 835,8	10 374,0	2 390,9	0,0
Solid	33 941,6	32 546,8	31 689,9	25 236,8
Oil	0,0	0,0	0,0	0,0
Gas	2 292,2	2 412,8	3 643,2	4 256,0
Biomass and waste				
hydro and other renewables	3 527,5	6 280,6	9 147,6	12 414,6
Wind				

Electricity generation TWh growth rate		-0,58%	-0,53%	-0,49%
FTE		-0,92%	-0,94%	-1,00%
Nuclear		-4,73%	-9,30%	-100,00%
Solid		-0,42%	-0,34%	-0,98%
Oil				
Gas		0,51%	2,34%	2,08%
Biomass and waste				
hydro and other renewables		5,94%	4,88%	4,28%

power stations. In 2020, the generation of electricity from coal would represent only 1% of total production. These new prospects would open onto the development of supercritical plants, which have a conversion efficiency (at around 50%) higher than that of conventional thermal power stations and which would become competitive from 2020 in comparison with combined-cycle gas stations. At the end of the projection period, the generation of electricity from coal would exceed its share in 1990 and 2000 (22% and 14% respectively), covering about 37% of total production or some 44,400 GWh.

The generation of electricity from renewable energy sources would advance significantly over the projection period (+3.1% per annum) and would reach 11,900 GWh in 2030. Around 60% of this production would come from wind turbines. However, in relation to the total electricity production, the share of renewable energies would remain small, and less than 10% in 2030 (it was 3.4% in 2000).

In this base scenario of nuclear exit, direct and indirect jobs should advance on average by 1% over the period 2000/2030, in phase with the growth in electricity generation (+1.25%). The exit from nuclear energy being accompanied by a resurgence of coal at the 2030 time-horizon, jobs linked to nuclear and coal energy should move in opposite directions: disappearance of jobs in nuclear energy compensated by job creation in coal-fired stations.

Alongside this, jobs in gas would advance over the period 2010-2020, only to decrease afterwards because of the competitiveness of coal. For their part, jobs in renewable energy would show strong growth over the whole period.

Observing the dynamics of jobs by generating sector raises several problems:

- The retraining of employees (direct and indirect) in the nuclear branch over the period 2015-2030 as plants are decommissioned.
  Taking account of the specialisation of occupations linked to nuclear energy in terms of both skills and remuneration, job mobility would be in fact relatively limited.
  The decrease in workforces will need to be managed in large part through career terminations. This poses quite naturally the question of nuclear subcontractors working on the "hot" parts (involvement regulated as a function of dosage). For subcontractors working on cold parts (steam turbine, alternator, command control, etc.), the development of the gas power station park, being replaced from 2020/2030 by supercritical stations, should allow affected employees to be reclassified.
  In conclusion, if some of the subcontractors' jobs can be converted, this is not the case for occupations specific to the nuclear branch. For the latter, appropriate support measures in terms of training in particular should therefore be examined.
- The development of training streams appropriate to renewable energy sources in particular in the maintenance area.
- Furthermore the development of employment in non-renewable energy sources is accompanied by a decentralisation of the means of production, which raises the question of their status, as illustrated in the German case.

Nuclear exit and energy efficiency in Germany

Involved like Belgium in the issues of nuclear exit, the German P&M scenario worked out by Wuppertal is distinguished from the Belgian BAU scenario by being part of an active and ambitious greenhouse-gas reduction strategy which is translated in particular by a decrease in electricity generation as an effect of increasing the energy efficiency of consumers.

This strategy relies on a major change in the system of production in favour of the development of renewable energy sources and electricity/steam cogeneration, knowing that at the 2020 horizon 70% will have to be renewed. Thus, at the 2030 horizon the share of renewable energy sources in electricity generation would be taken to more than 15%, and that of cogeneration to 32%, to be taken to more than 65% at the 2050 horizon.

The scenario (chart opposite) shows a drop in total employment in maintenance and operation over the period considered, accompanied by a quadrupling of jobs in renewable energy in 2020 and a drop of 25% in jobs in coal-fired stations.

The development of cogeneration and renewable energy would result principally from decentralised self-generators. Thus, to the questions of retraining raised above in the case of Belgium is added the question of the status of employees in relation to the development of decentralised production.

1.5. Opportunities, challenges and risks for employment in the electricity sector

Risks and challenges

The application of policies and measures in favour of a low-carbon, highly energy-intensive economy confronts the electricity companies with the double challenge of a slow-down, even reduction, in the demand for electricity and of the fall of employment in coal-fired power stations.

The risk of a decline in employment in electricity generation, highlighted by the analysis of the scenarios, shows up in the projections made at the level of Member States. In Germany, for example, a study by Irrek and Thomas[30] estimates that an energy-saving programme leading to a reduction of energy demand of around 10% of current end consumption by 2015 would result in a loss of 17,000 FTE jobs on average in the energy sector by 2029 (409,000 man-years).

Such trends would be added to the big decrease in employment recorded in the electricity sector since 1997 – estimated at around 300,000 jobs[31] – as a result of the liberalisation of electricity markets, privatisations and technical progress. Observers also predict that these negative trends will persist because of liberalisation and do not anticipate a resurgence of employment because of the limited prospects of growth and innovation[32].

The issue of the substitution of gas or renewable energy sources for coal for electricity generation raises the question of the substitutability of jobs. This is generally considered possible between generation technologies using fossil fuels (coal and gas), but very limited in relation to other technologies (renewable, nuclear). It is also difficult to move from a safety technician's position in a fossil-fuel power station to a job consulting or performing energy audits for clients.

For electricity generators, currently engaged in a phase of concentration and redefinition of their business model, the joint development of renewable energy sources and energy efficiency demands a change in their organisational model combining decentralisation with proximity services.

Thus, although the technical competences associated with the sector remain current, the accent from now on is less on traditional base activities like network maintenance. If functions of this type continue to be part of activities, although sometimes outsourced, it is more probable now that technical competences will be required in combination with project-management skills, particularly managing energy-efficiency, diagnostic and commercial-development projects.

The question of closing coal-fired stations is closely connected with mining-sector employment. Coal retains a strategic role in electricity generation in coal-producing countries by offering an outlet for mine production. In the coal-producing new Member States, Poland and the Czech Republic, the social cost of possible reductions in mine production is important. In Poland it is estimated at 35,000 jobs. Moravian Silesia, the Czech Republic's principal mining region, has been particularly affected by a drastic

[30] Irrek W, Thomas S, et al, Der energieSparFonds für Deutschland, edition 69 der Hansböckler shiftung, 2006
[31] PSIRU, ECOTEC

[32] European Central Bank (2001) 'On price effects on regulatory reform in selected network industries'

disappearance of heavy industry, and underwent, up to 2004, a practically uninterrupted increase in unemployment.

Finally, another important question concerns the impact on energy employment of a nuclear-exit policy associated with an active and ambitious greenhouse-gas reduction strategy. This question is raised in the countries which have made political commitments to progressive nuclear exit, represented in this study by Germany, Belgium and Spain. In Germany, existing studies do not reach the same conclusions as to the net effect on employment. Some highlight negative net impacts, while others show that positive effects could result.

Opportunities

The development of emission-reduction policies and measures offers new prospects for development favourable to employment in the electricity sector, of which the electricity companies could at least in part take advantage. The medium-term issue, however, appears to be more one of preserving employment in the electricity sector than increasing employment in absolute terms.

Renewable energies

All studies carried out to date converge from the point of view of the positive gross impact in job terms of renewable energies. Without being exhaustive, we can quote the prospective studies of ECOTEC, ISI, EEG, ECOFYS, KEMA and REC[33]. The potential for job creation in renewable energies is estimated at…

On the other hand, the net impact of renewable energies on employment is the subject of debate among experts, centred on the effect on the economy as a whole of the increase in electricity prices[34]. The results depend in large measure on the characteristics of the model used.

Over time, jobs would evolve gradually away from manufacturing and development sectors in favour of those in operation and management. In 2020, a large part of these jobs would have the aim of ensuring the functioning of existing installations.

Renewable energy sources offer job opportunities in rural regions.

Energy services[35] (i.e. energy audits, energy performance contracts)

These commercial services are offered to help end users take advantage of the enormous potential of energy efficiency. There exist various estimates of the potential of energy performance and the possible developments of this market. In Germany, the Berlin energy agency, in the public sector alone, estimates that 2 billion euros could be invested in performance contract projects, allowing energy savings of more than 350 billion euros a year. According to the association of energy service companies (ESCOs) "Contracting-forum im ZVEI", the potential of various types of energy service contract projects is 26.5 billion euros per year.

However, obstacles and barriers to the development of these services are numerous and the development of this market has not happened in full, despite expectations raised by market liberalisation. Recently, in any case, with the help of energy price rises, an increased interest in these services has been observed. Whereas in the years following the process of liberalisation, energy performance contracts were only a small proportion of the supply-side projects put in place, genuine energy services contracts are now being implemented.

[33] ECOTEC (2002), Renewable Energy Sector in the EU: its Employment and Export Potential. M. Ragwitz, J. Schleich, Fraunhofer ISI. C. Huber, G. Resch, T. Faber, EEG. M. Voogt, R. Coenraads, ECOFYS. H. Cleijne, KEMA. P. Bodo, REC: FORRES 2020: Analysis of the renewable energy sources' evolution up to 2020 -2005-

[34] cf national report for Germany within the framework of this study, Wuppertal Institute, February 2007

[35] cf national report for Germany within the framework of this study, Wuppertal Institute, February 2003

In Germany, 50,000 contracts of this type are supposed to have been entered into at the end of 2005. There are 500 businesses offering this type of service, some independent, others part of or subsidiaries of energy companies. In Germany, there are 3 ESCO associations.

Employment figures in these sectors could not be found.

Expansion of heat-electricity cogeneration

The technical/economic potential of heat produced by co-generation is major. In Germany, it is estimated at 30% of the heat used and 57% of the electricity generated today. Cogeneration allows savings of primary energy and CO_2.
Cogeneration installations are generally situated near the site of heat consumption. Currently, the new stations use gas, but other fuels as well as renewable energy sources (biomass) are used.

Impacts on employment are very similar to those of fossil-fuel power stations. Additional positive and negative effects come from the construction and operation of urban heating systems. An integrated analysis of the employment generated by cogeneration would have to include employment in the cogeneration station, the jobs linked to the urban heating network, and the jobs generated indirectly by savings of fuel purchases, e.g. gas.

In 2000, the German union VER.DI estimated the employment in municipal cogeneration stations at 20,000 man-years.

High-efficiency coal-fired power stations

New types of coal-fired power plants of high efficiency, up to 50%, will be available from 2010. Although they will be very efficient, they will still emit large quantities of CO_2 as a result of coal usage. Nonetheless, such technologies will be necessary in the transition towards a sustainable energy system.

In general, the operation of a new thermal power plant requires only a half or even a third of the employees of the old station it replaces. For the three-year construction period of one of these types of stations currently being discussed in Germany, around 6,200 man-years of direct jobs are generated (gross impact)[36].

Such technical innovations will give a comparative advantage in terms of know-how and help to secure employment in electricity companies, as well as with technology suppliers.

1.6. Recommendation for climate policies

Choices made in the field of energy technology very largely determine the jobs induced by investments made in Europe, but also by those made in other regions of the world (Asia, America, Central Europe). From this point of view, no technology should be discarded. So the best technological mix seems to rest on a policy aiming towards development of all technologies (renewable energies, clean coal, nuclear, sequestration, hydrogen) in order to allow European industry to be a major player at the global level for all these technologies.

Thus it appears that any public policy in favour of an ambitious reduction in greenhouse gases should include three inseparable aspects:

- new impetus to the control of energy,
- ambitious R&D support for renewable energies and low-carbon technologies,
- deployment of all available economic instruments while taking care to minimise possible undesirable side-effects.

Such a policy urgently needs to be put in place because any delay will make later efforts more difficult.

Public authorities must set the example: the State and local councils, as large consumers of energy, of goods and of services, as well as adjudicators of public tenders.

The potential loss of competitiveness by European businesses due to their adaptation to a more expensive energy "mix" is to be dealt with attentively. It is also admitted that there are

[36] National report for Germany within the framework of this study, Wuppertal Institute, February 2007

positive effects for companies that adapt first ("first mover advantage").

1.7. Recommendations for social support policies

There is no doubt that the transition to a "low-carbon" economy will induce significant structural changes in the electricity generation sector.

Tools for prospective management of competences should be being put in place as of now to ensure job mobility for employees in the sector to the new occupations linked with decentralised energy production and efficient energy usage. The development of training streams appropriate to renewable energy sources is necessary, in particular in the maintenance area.

If previously enterprises concentrated principally on distributing electricity to customers, emphasising network maintenance and technical services, with the decentralisation of energy sources and the development of energy services, competences need to be reoriented so as to encompass the following functions:

- marketing functions with a view to keeping current customers and attracting new ones, and responding to their needs in terms of energy efficiency (diagnostic, monitoring);
- project-management functions, concerning for example planning installations or buildings with high energy efficiency;
- functions of decentralised management of electricity and heat grids;
- customer-service functions through call centres providing information, marketing or maintenance services.

Moreover, there is a general risk – which is not specific to climate-related policies and measures but also concerns other sectors such as ICTs – that the jobs that arise in new businesses in new services and products will be less well-paid, with less secure employment conditions, than in established branches. This applies in some renewable energy companies[37] or energy services companies. Consequently, as several unionists have mentioned in interviews, it is necessary, not only to promote the development of renewable energy sources and energy efficiency to secure or create jobs, but also to monitor the quality of those jobs.

[37] Grundmann, M. (2005): Branchenreport Windkraft 2004: Arbeitsorientierte Fragestellungen und Handlungsmöglichkeiten. Arbeitspapier 99 der Hans-Böckler-Stiftung, erstellt von der schiff GmBH mit maßgeblicher finanzieller Unterstützung der IG Metall, Düsseldorf.

2. The petroleum sector

2.1. A world supply shortage of petroleum products and European consumption marked by an increase in diesel fuel

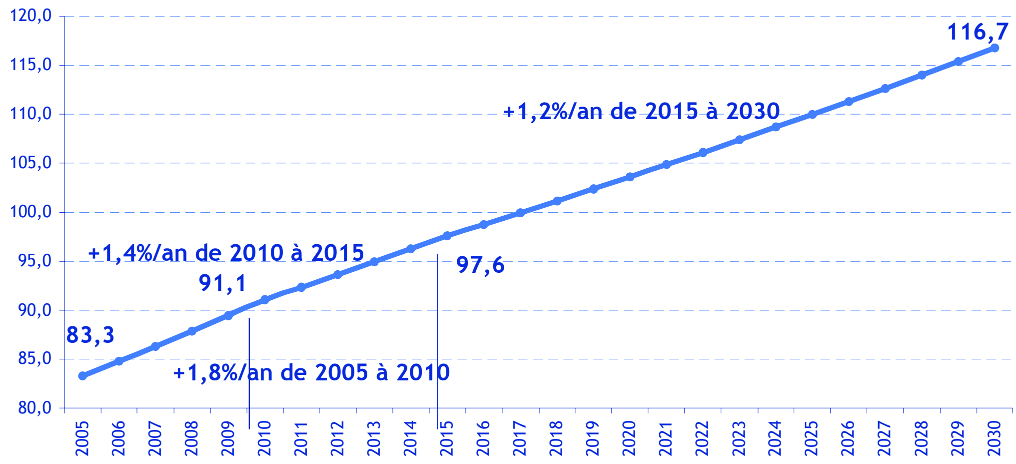
A sharp increase in world demand for petroleum products

On the basis of projections carried out by the IAE to 2030, those carried out by the petroleum groups themselves and industry bodies like Concawe[38] (Europe), the demand for petroleum products is evaluated at 83.3 Mb/day in 2005, at 97.6 Mb/day in 2015 and about 116.7 Mb/day at 2030.

This projection (+40% in 2030, or +1.6%/year) is in a fairly low-range scenario (the high scenario is +60% in 2030) and registers:

- A disparate growth in demand in different geographical zones: very low in Europe, medium in North America and strong in the Asia/Pacific zone;
- The rise of energy sources – established or recent – which may be substituted for certain uses of petroleum products (such as gas, coal, biomass and waste), either for electricity generation or for final consumption (industry, transport and residential);
- A lowering of energy intensity – the quantity of energy needed to produce a euro of GDP – as energy efficiency improves and the contribution of heavy industry to the world economy diminishes.

Figure III.6. : Estimation of world consumption of oil products from 2005 to 2030 (in Mb / day)



Source : AIE avec de 2015 à 2030 prise en compte du scénario dit alternatif (bas)

[38] CONCAWE is the technical body of the "European Petroleum Industry Association". EPIA represents the European refining industry (90% of refining capacity) and 75% of fuel retailers.

Moderate advance of petroleum product consumption in the European zone and development of diesel fuel

Based on data from Concawe and the IEA, the level of consumption of road fuels would go from 287.9 Mt in 2005 to 290 Mt in 2030, or an annual increase of 0.5% per year[39].

The biggest changes in the consumption of petroleum products in Europe (25) will be in road fuels (diesel and petrol) and jet (aviation) fuel[40].

According to Concawe, the progress of road transport fuels to 2015 or 2020 (even 2030) is the non-linear result of various factors such as:

the growth of the automobile fleet of new entrants and of European road transport;

the contraction in consumption linked primarily to more economical engines, to the reduction of speeds, to the development of shared transport and obviously to the effect of biofuels.

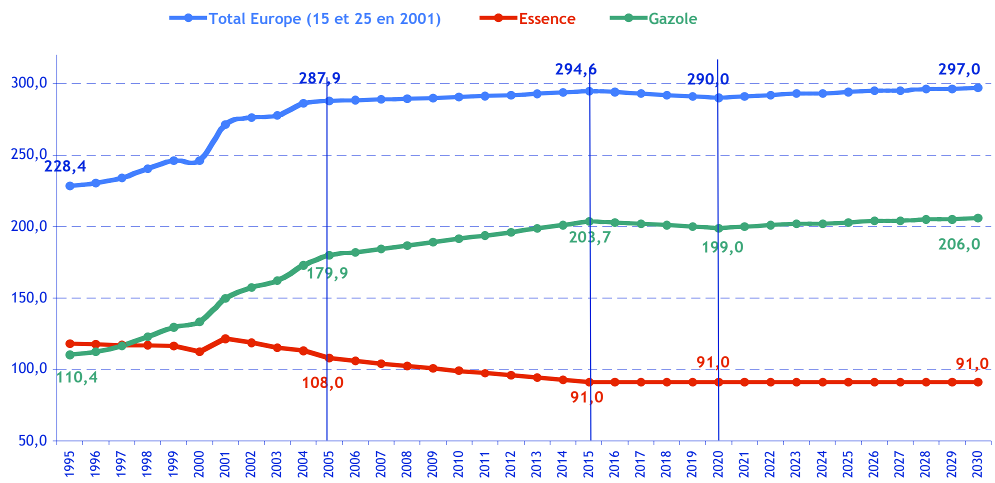
This evolution does not include, in particular in the 2020-2030 projection, any technological jump or change of economic model.

Petrol consumption at 108 Mt in 2005 would continue to decline at an average rate of -1%/year from 2005 to 2020 (-17 Mt in 2015 and in 2020). Petrol, which represents 37.5% of road fuel consumption in 2005, would move to 31% in 2020.

Diesel fuel, with close to 180 Mt in 2005, would move to 204 Mt in 2015 and 199 Mt in 2020, or an average increase of +0.7%/year. At the 2015 horizon, this situation would involve an additional production of nearly 24 Mt of diesel fuel by refining, but at 2020, or even at 2030, this situation would remain unchanged overall.

According to Concawe, the development of diesel oil is marked from 2015-2020 by a twofold movement, of contraction of the tonnages consumed by private vehicles and the continued growth of the tonnages consumed by road transport.

Figure III.7. : Europe : projections by CPDP and Concawe of road fuel consumption in Mt (UE-25 from 2001)



Sources : CPDP, Concawe et projection Syndex de 2020 à 2030 sur les bases Concawe

[39] Concawe, Road Transport fuels for the Future, June 2006 and IEA, World Energy Outlook 2004

[40] The European zone is marked by a particularity in relation to other geographical zones in that diesel has become the dominant fuel as of 1998.

But this approach may be limiting...

Concawe's projection to 2020 limits consumption movements very significantly:

- by projecting to 2020 (+0.7%/year) a movement very greatly out of step with the historical trend for diesel over long and medium periods (+6.3%/yr from 1995 to 2005 and +4%/yr from 2001 to 2005)
- by reducing to -1%/yr the decline of petrol whereas the trend between 2001 and 2005 is -2.2%.

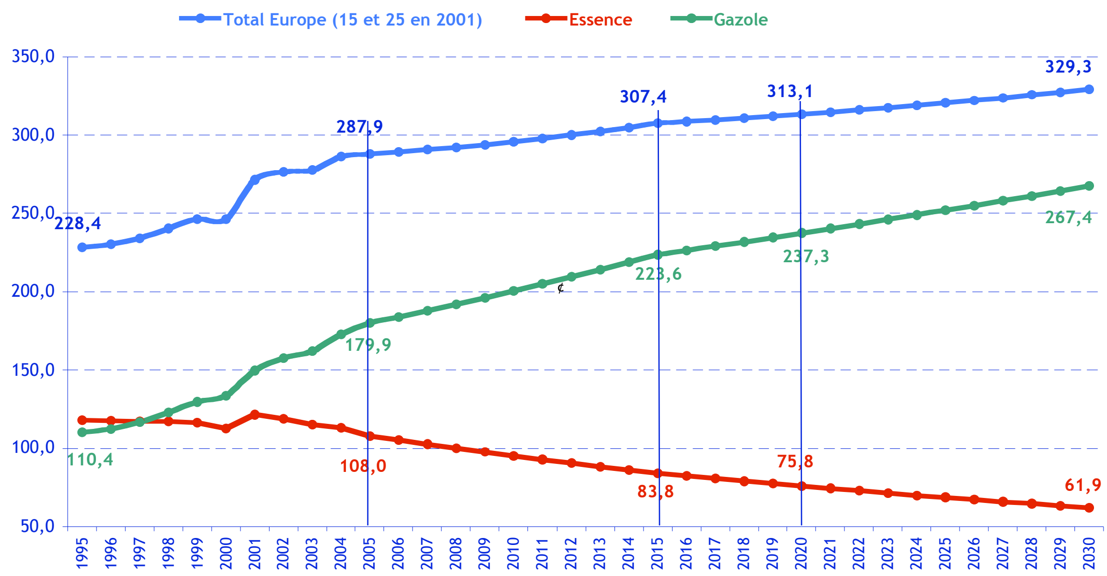
The movements projected by Concawe on these products remain confined in a diesel/total fuels ratio that does not exceed 70% in 2020 (62.5% in 2005 and 68.6% in 2020) and does not fundamentally affect the production structure of European refining.

Taking account of these remarks and taking up the essence of Concawe's arguments, we propose an appreciably different and plausible projection, with a growth in road fuels of +0.58%/yr from 2005 to 2020, comprised of a +1.3%/yr movement in diesel and a decline in petrol of -1.7%/yr.

In this configuration, the diesel/all fuels ratio exceeds 70% from 2015. The technological structure of the majority of the European refinery industry is affected.

This projection and the comparison with that based on Concawe's perspectives show the extreme sensitivity of the European refining industry to future demand movements, in particular for diesel fuel, and to continuation of the dieselisation of Europe.

Figure III.8. : Europe: projection by Syndex of road fuel consumption in Mt (European Union - 25 from 2001)



Sources : estimation Syndex de 2005 à 2030

2.2. Characteristics of the European refining industry and orientations to 2015-2020

European refining capacities, their localisation and their access to the resource

European capacities and their localisations

European refining (Western Europe and Eastern Europe including the CIS) possesses in 2005 refining capacities for a level of 1,262.6 Mt (close to 30% of global capacity); excluding the CIS (396.4 Mt), European refining capacity is 866.2 Mt; for the Europe of 25, this level is 749.7 Mt and remains relatively static apart from the development of creeping capacities....

The Europe of 25 represents, in 2005, 17.6% of world refining capacity and more than 59% of the total European capacity including the CIS. These capacities are organised around 106 refineries essentially concentrated (77 units) in seven countries (in order: Germany, Italy, France, Great Britain, Spain, the Netherlands and Belgium) which alone possess more than 77% (580 Mt). Close to 50% of these capacities are situated in North-West Europe (the eastern Mediterranean zone 40%, Central Europe around 10%).

Access to reasonably light, low-sulphur crudes in transformation

The quality of crude oils in the European zone is strongly linked to the geographic ease of access to the resource, in particular with the importance taken on by North-Sea Brent, as continues to be shown by the current structure of crude oils used.

Thus, in the North-Western Europe zone (50% of European capacity), Brent, light and low in sulphur (< 0.5%), from the North Sea represents 50% of the supply to the zone.

The Mediterranean zone (40% of European capacity) is characterised by a less light and higher-sulphur (between 1.2% and 2%) resource; supplies are principally organised around crude oils like the Arab/Iran mixes, Urals, and Saharan blends.

In Central Europe (10% of capacity), 80% of supplies come from the Urals type (a heavier crude than Brent and containing on average 1.25% sulphur).

On the one hand, these accesses tend to configure the apparatus of production towards production of the lighter cuts (petrols...), and, on the other hand, they limit investments, in particular in desulphurisation.

It will be observed that since the mid-1990s the threefold impact of dieselisation, the toughening of product specifications in Europe and a trend for the barrel to get heavier[41], transformations in the rate and level of investments are starting to take effect.

The characteristics of the tools

The vast majority of the European refining apparatus is uses a configuration based on FCC, since 75% of refining is either in an FCC + VB (catalytic cracking plus visbreaking) configuration, or, more recently, FCC + VB + HCU (hydrocracking).

Of the 106 refineries (104 not counting lubricants) taken into account over 2005:

- 34 (33%) are so-called simple refineries (atmospheric distillation) with or without visbreaking;
- 40 (38%) are so-called semi-complex 1 (36 fluid catalytic cracking and 4 FCC & coker);
- refineries including one or more hydrocracking units number 30 (29%). Of these thirty, two refineries include all these installations plus coker, enabling deep conversion (Germany and Spain).

[41] The increased weight of the barrel results from the foreseen contraction of North Sea reserves and the rise of heavier crudes from other zones (FSU, Arabian Peninsula...).

Only a third of European refining is in a satisfactory position to produce middle cuts, and in particular the diesel oil necessary for the heavily dieselised European market, which explains the level of imports (see below).

More worryingly, in relation to European issues of the abolition of heavy fuel oil, only two (deep conversion) refineries are in an optimal position.

Overall, the European refining industry has made investments over the last few years allowing the implementation of the technical adaptations needed for changes in the specifications of products (tightening of emissions standards) but in a refining paradigm that only very sketchily answers to the changes in European demand (increasing quantities and weights of diesel fuel) and hardly at all to the issues of the reduction/abolition of heavy fuel oil.

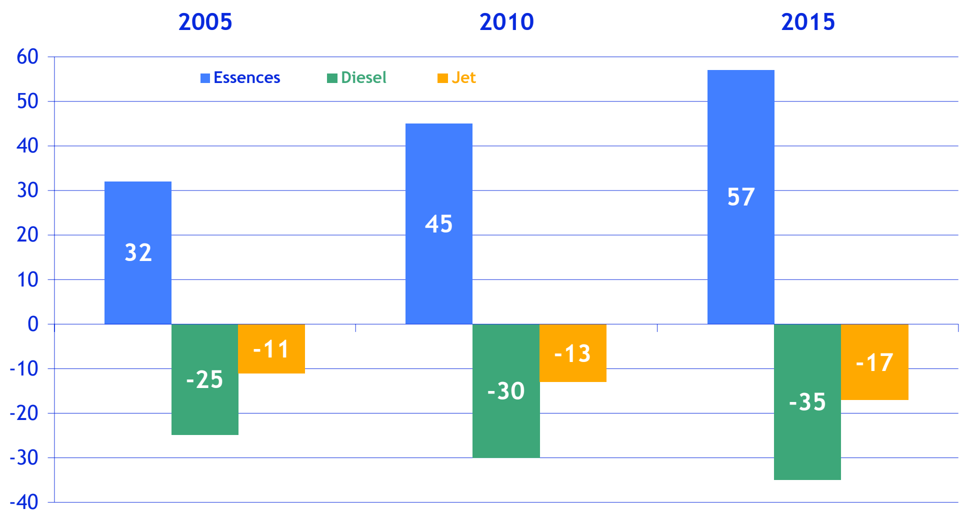
2.3. Projections of the European refining industry to 2015-2020

Development centred on moderate growth in hydrocrackers to 2012-2012, leaving the issues of the reduction in heavy fuel oil for later

The changes projected in Europe are essentially based on the construction of hydrocrackers producing middle distillates:

- 10 units are firmly planned by 2010/2012 (built, in construction and final approvals), three in Italy, two in Spain and two in France, for an additional level of production of middle distillates which can be estimated at 12 to 20 Mt/year; complementary investments in desulphurisation planned

Figure III.9. : Europe : evolution of main oil products - 2005 to 2015 in Mt



for many refineries (growth in HTS crudes entering refineries) possibly allowing an increase in the production of middle cuts of 8 to 15 Mt/yr (these estimates are taken into account in the previous calculation of the shortfall in diesel in the European zone);

- in the longer term (beyond 2012-2015), ten planned complementary hydrocracking units are being investigated over the European zone.

Deep conversion projects, indispensable in the zone to reduce and eliminate heavy fuel oil, are largely deferred until after 2012-2015.

Movement in capacities in Europe not adapted to demand

Over the European zone, the development is translated by increased need of historic imports of diesel fuel in the future (coming largely from the former Soviet republics).

Taking into account advances known – to this date – in middle cut production in Europe by 2015, the shortfall in diesel fuel would reach 35 Mt/yr and that of jet fuel 17 Mt/yr.

The economic balance of Europe remains tied to the capacity to discharge surplus petrols over the Atlantic basin (graph III.9.).

The development of imports of diesel to European standards is one of the orientations taken by refiners

The investment orientations of refiners to 2012-2015 show that covering the European zone's shortfall in diesel by internal production is not a strategic orientation sought by the refiners. This situation in Europe translates an opportunity strategy on the part of refiners:

- The lasting mismatch of the productive apparatus to demand movements tied to the weakness of investments allows the industry to benefit from lasting tensions over diesel fuel, maximising refining margins and profits.
- Exports of surplus petrol to the United States, where the refining industry is showing weaknesses, consolidate this situation.

Several factors seem to be determinant for this strategy:

- the dynamism of the European market in the medium and long term is judged insufficient for major investments to be made;
- the future level of tightening of European standards remains largely unknown;
- the level of CO_2 allocations and the price per tonne of CO_2 may move unfavourably in the medium and long term, inducing negative effects on refining margins.

Compensating this poor internal adaptation of the European productive apparatus to markets, multiform refining projects have been developed to a great extent on the Arabian Peninsula, and more particularly in Saudi Arabia, by the large global refiners (ExxonMobil, Shell, ConocoPhillips and Total) en association with Aramco (Saudi Arabia holds 25% of the world's reserves).

The last two refining projects presented in 2006 for commissioning around 2011-2013 (that of ConocoPhillips / Aramco on the Yanbu site and that of Total / Aramco on the Jubail site) give an indication of current strategic orientations. These two projects revolve around building two "converting" refineries of 20 Mt/yr using heavy crudes and allowing very flexible production of petroleum products to the various standards (American, European...) for export, at the same time destroying heavy fuel oils.

Complementing this development, we should not exclude the investments realisable by firms from the former Soviet republics to conform their production of middle cuts (principally diesel/fuel oil) to European standards so as to secure their exports to Europe, which constitute an important historical flow. Two schemas can be envisaged:

- a rise in desulphurisation and hydrocracking investments allowing exports to be conformed to European standards in major refineries;

- investments in "initial treatment" such as desulphurisation reducing the gap between the characteristics of current products and European standards; they European refining industry carrying out final treatments to this basic "feedstock" at low cost and at the same time with greatly reduced CO_2 impacts.

A future situation which perhaps clears the way for reorganisation of the European refining sector

In a future European context of little change in the consumption of petroleum products, of investments in refining limited to adaptations to standards and minimal adjustments to the market, and of greater openness of the European market than in the past to imports of products derived from middle cuts, the risks inherent in a partial reorganisation of the sector from 2010-201 exist.

Despite the existence of a European shortfall in middle cuts and of high margins for good-level refining at least until 2010-2012, the cost of the necessary investments in Europe could translate into an investment flow limited to refineries of good size and refining hubs (connection of several refineries).

These investments concern desulphurisation units, hydrocracking units and additional cookers for reducing heavy fuel oils. These costs, which depend on the nature of the installations and on the complexity of the process, can be evaluated from our point of view at between 100 and 400 million euros per project on average.

The end consequence of these changes may be a contraction of direct employment in the European refining industry and impacts on indirect jobs in this industry.

2.4. Refining and movements in emission levels

A change in the specifications of the products which leads to an increase in emissions from refining

The specifications of the products

The European refining industry is caught up, since the European Directive of 1998 concerning the quality of petrol and diesel fuels[42], in a logic of product evolution with the object of reducing polluting emissions, in particular from motor vehicles (Auto-oil). This directive and those following (2000/71/EC, 2003/17/EC and regulation 1882/2003) are translated by specifications of products, obligatory from 2000 and 2005, according to a defined schedule with some exemptions.

These requirements for lead-free petrol and for diesel fuel concern respectively:

- octane number, vapour tension, evaporative distillation and amounts of aromatics, benzene, olefins, oxygen, oxygenated sulphur and lead compounds contained,
- cetane number, density, distillation, polycyclic aromatic hydrocarbons and sulphur content.

These specifications, which have been strengthened over time, aim primarily in the framework of the Auto-oil programme to lower the level of sulphur in fuels to 50 ppm (parts per mission); the Auto-oil II programme strengthens these provisions by making general by 1 January 2009 a requirement of 10 ppm in fuels (petrol and diesel).

This evolution of the specifications (Auto-oil and Auto-oil II programmes) is coupled with an

[42] Directive 98/70/EC.

evolution of the vehicles put on the road through the "Euro" emission standards. Currently, the Euro IV standards relate to vehicles put on the road between 2005 and 2007. The Euro V standards, which should be applicable by 2008/2009, reinforce the reduction of emissions of light vehicles by including all-terrain and 4x4 vehicles over 2500 Kg. Euro V could be accompanied by a proposal aiming to reinforce emissions standards for heavy vehicles and lorries.

The application of Euro V should translate to a reduction, for diesel-engine vehicles, of -80% in particulate emissions and -20% in oxides of nitrogen (NOx); for pure-petrol vehicles to a reduction of -25% in NOx and hydrocarbon emissions. For vans, the reduction in particulate emissions would be -90% and those of NOx -20%.

Increasing emissions from refineries

Generally speaking, the level of CO_2 emissions from a given refinery depends on numerous factors such as the API weight of the crude oil(s) used, the degree of cracking being aimed out, the proportion of products that are light (petrol), middle (diesel/heating oil, jet fuel) and heavy (fuel oil, bitumen, residues...) leaving the refinery, the degree of complexity of the tools deployed.

Products like petrol and diesel demand the application of a higher and more complex process which leads to a high level of CO_2 emissions.

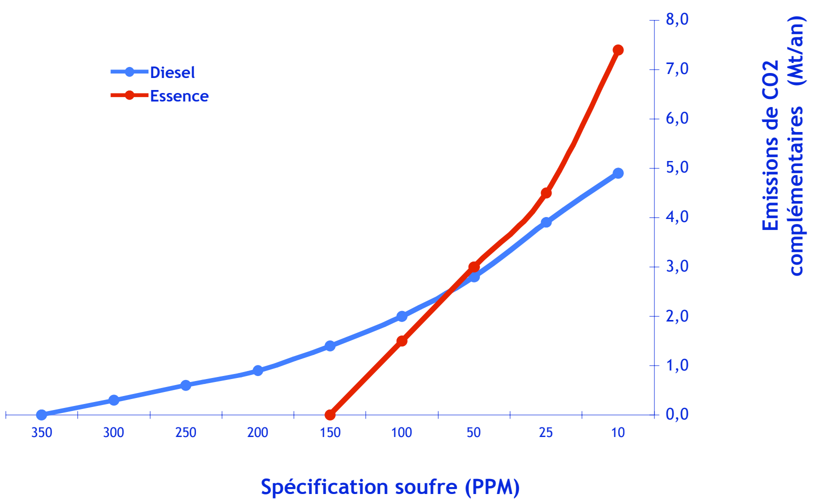
According to the IEA, the weighted mean of crudes and installations in North-West Europe (48% of European production and CO_2 emissions) produces 0.33 t CO_2 / tonne of crude petroleum (the Mediterranean zone figure is 0.32 and for Central Europe 0.34).

The reduction of sulphur in petroleum products, most often implemented by hydrodesulphurisation, necessitates not only a greater energy consumption linked to the installation but also a greater consumption of hydrogen, which ultimately leads to an associated increase in CO_2 emissions.

According to Concawe, the increase in CO_2 emissions tied to the reduction in sulphur would, for European refining, be close to 7.3 Mt/yr by 2010 in relation to the emissions of 2000.

The associated investment cost to comply with environmental objectives is, according to Concawe, valued at +6.7 billion euros or +€6.2/tonne of sulphur-free products. It will be observed that effect of changes in the specifications on CO_2 emissions is not linear but increases much more rapidly.

Fig. III.10. : Impact of new sulphur specifications on CO2 emissions



Source : Concawe

2.5. Refinery emissions and the allocations of emission rights under the NAPs

Phase I emission rights allocations

In phase I of the NAPs (2005-2007), the allocation of emission rights for the petroleum sector strongly reflects a choice to favour compliance with the new product specifications (sulphur in particular), at the expense of reducing CO_2 emissions. In other words, the emissions allowed by the NAPs incorporate in advance the effects of the directives on sulphur emissions in attributing emission rights.

In the end, over this phase I, the emissions situation of refining in the Europe of 25 is translated into a general overallocation of more than 8 Mt. Over 2005, the refining sector for the Europe of 25 emitted 145.3 Mt of CO_2 of which 119.2 Mt was in the major refining countries (Germany, Italy, UK, France, Spain and the Netherlands), for an initial allocation of 153.6 Mt of CO_2.

It will be observed that only the German and Spanish refining industries were situated above the ceiling initially set, Italy (another major refining country) being the country with the lowest gain in emissions.

Prospects for phase II emission rights allocations

The phase II NAPs over the period 2008-2012, on the basis of current national communications, remain within the logic of the phase I NAPs as far as the refinery sector is concerned.

The NAPs take into account as their primary reasoning the reductions in sulphur emissions and improvements in the specifications of petroleum products; this orientation has as a consequence an increase of CO_2 emissions for this sector.

One reason is that the production of “clean” road fuels (petrol and diesel) contributes indirectly, in combination with the Euro emission standards applied by the automobile industry, to the improvement and to the reduction of emissions in the transport sector.

The estimated level of CO_2 emissions of the refinery sector of the EU-25, over the period 2008-2012, should increase in a range between +6 and +8% compared with the level of verified emissions for 2005. The annual level of emissions over the period 2008-2012 of the refinery sector would be between 154 Mt of CO_2/yr and 157 Mt of CO_2/yr.

The estimated level of emissions above differs from that of emission allocations which would be situated around 132 Mt CO_2/yr over the period 2008-2012, i.e. a drop of 0.9% compared with the verified emissions of 2005.

Table III.11. : Allocations of emission rights to refinery sector Phase I (2005-2007), European Union - 25 and main countries

Pays	Allocations 2005 (CO2Mt)	Emissions validées 2005 (Mt de CO2)	Bilan des émissions (MtCO2)	Emissions validées /Plafond en %
Allemagne	28,9	29,0	-0,1	100,3%
Italie	24,4	24,0	0,4	98,4%
France	20,2	18,2	2,0	90,1%
Royaume-Uni	19,6	18,4	1,2	93,9%
Espagne	17,2	17,5	-0,3	101,7%
Pays-Bas	13,6	12,1	1,5	89,0%
Belgique	6,6	5,6	1,0	84,8%
Suède	4,0	3,2	0,8	80,0%
Total pays majeurs	**134,5**	**128,0**	**6,5**	**95,2%**
Autres pays	19,1	17,3	1,8	90,6%
Europe 25	**153,6**	**145,3**	**8,3**	**94,6%**

Source : CITL

2.6. Medium- and long-term employment changes

Quantifying jobs in the sector

Eurostat statistics are only informed in a very patchy way of the number of persons employed in the Europe of 25 by the refinery sector. Among the major refining countries, only countries like Italy, France and Spain give out information; for a number of other countries this information is classified as confidential.

If information about direct jobs – in the sense of persons employed – in refining is patchy, it is clearly nonexistent for indirect refining jobs, where, however, subcontracting is both a long-standing and a major phenomenon.

Besides this, to these difficulties in measurement should be added the effects linked to delimiting the boundary of refining activity:

- in the case, for example, where the refinery is very closely integrated with petrochemical activities the delimitation of jobs between refining and petrochemicals is not always simple;
- depending on how the petroleum company divides up its operations, some activities, such as logistics for example, may be included in refining or, on the contrary, be placed in petroleum marketing, i.e. at the other end of the supply chain. Certainly, in this precise case, direct jobs in logistics carry little weight compared with refining, but this activity is heavy in indirect jobs in transport subcontracting.

On the basis of various available pieces of information, we estimate the direct jobs in European refining (including estimated logistics jobs) in a range between 110,000 and 130,000 jobs.

This estimation makes use of refining capacities and the number of persons employed where this information exists in the Eurostat statistics.

We took the persons employed in refining in 4 countries (France, Italy, Spain and Poland) from Eurostat as a basis on one hand, and on the other the refining capacities of these same countries. Knowing that the volume of refining capacity per number of persons employed is directly tied to the overall level of refining capacities:

- the sum of Spain, Italy and France, for example, occupies, on the basis of Eurostat, 42,412 for a refining capacity of 280.3 Mt/yr or an average level of 6.6 Kt of capacity per person employed; Poland, whose capacity is 23.3 Mt/yr, employs 9,687 persons, or a level of 2.4 Kt/yr of capacity per person employed. One notes with these ratios that the lower the total capacity of a country is, the proportionally greater is the number of persons employed, which leads in relation to European refining to an upward weighting of the number of jobs;
- it will also be observed that on the basis of data from petroleum companies the level of capacity per person employed may reach, for a significant level of refining, levels of the order of 13 Kt of capacity/yr, or almost double the European average of the three major refining companies quoted above.

For the European refining sector, the situation to 2012 remains relatively favourable.

The increased dieselisation of the European fleet favours, despite engine evolution in the short term, the increase of fuel demand.

The shortfall of diesel/heating fuel continues to create tensions over products and favours a refining margin level sweetened by petrol exports.

From this point of view, the incorporation of biofuels to the extent of 5.75% by 2010 over the European zone facilitates products supply without really harming current refining balances.

Compliance with European Directives on low-sulphur fuels is translated at the level of European refining by a significant increase in CO_2 emissions at least until 2010. The various national NAPs have incorporated this constraint. Investments in the refining sector remain concentrated on the “sulphide” constraint.

It will be observed that proposed investments in or implementations of desulphurisation at least until 2010-2012 remain few in number and will probably remain confined to refineries of good size and to refining hubs.

In the event, the investments needed to reduce emissions and limit/destroy heavy fuel oil are deferred.

These characteristics of the evolution of the sector to 2012 contribute, from our point of few, to very small structural changes to the level of direct and indirect refining jobs. Overall, the level of jobs in the European refining industry should remain stable to 2010-2012 or, according to our estimates, an average level of 120,000 jobs.

The employment changes which may take place in this sector to that date will be either due to economic circumstances or linked to small adjustments.

Possible changes in employment beyond 2012-2015

Beyond 2012-2015, the sector may be traversed by different and concomitant orientations according to a dynamic articulating the internal and the external.

The internal European dynamic

The dynamism of the European market in the medium and long term is judged insufficient by the industry for major investments to be made;

- the future level of tightening of European standards beyond 2012-2015 remains largely unknown;
- the level of CO_2 allocations and the price per tonne of CO_2 may move unfavourably in the medium and long term, inducing negative effects on refining margins.

We have seen that covering the diesel/heating fuel deficit of the European zone by internal production is not a central strategic orientation of refiners, and this even if some investments (hydrocrackers) are made at the European level.

The introduction of biofuels, in particular biodiesel, allows refiners to reduce the European deficit in diesel/heating fuel by outsourcing.

Conversion projects will probably only really be implemented beyond 2015 and then selectively, taking account of the induced investment costs.

The external dynamic

Compensating for this low level of internal adaptation of the European productive apparatus to markets, two complementary approaches may allow the European refining industry to limit its investments in the zone by delocalising production:

- the continuation and extension of multiform refining projects such as those currently in course on the Arabian Peninsula, where CO_2 constraints, even if they develop, will remain very modest;
- the second possibility, which cannot be excluded, resides in a rise in imports of desulphurised products from the former Soviet republics.

Jobs which, according to the scenarios, may be increasingly affected

On the basis of the estimated range of direct jobs in refining (110,000 to 130,000, or 120,000 on average), we offer an evaluation of the various effects on employment which may result from the various scenarios. These scenarios are not intended to give job movements with any precision, but aim to characterise in broad strokes the effects on employment induced by the sector's orientation:

- the first scenario takes account of the development of hydrocrackers as projected to 2012-2015 and retirement of some refineries whose capacity level is lower than 5 Mt. Some refineries under 5 Mt are not in a position to bear the costs induced by the investments need to comply with standards without a major loss of profitability. We estimate that this situation may affect 5 to 10% of refining jobs (the graph shows the average of this impact, or 7.5%).

- the second scenario from 2015 takes into account the necessary contraction of the "bottom of the barrel" and the development of conversion capacities complementing hydrocracking. For the same reasons as in scenario 1, a new selection of refining units is made. We estimate that this situation may affect 10 to 15%% of jobs (12.5% on the graph).
- the third scenario anticipates an increasing development in imports well beyond what is predicted for 2015 (52 Mt shortfall of middle cuts):
  - the effects tied to increasing imports may vary depending on whether we are importing finished products to European standards or "feedstock" needing further treatment in a refinery. This develops in a framework where European standards and CO_2 constraints are strengthened for refiners by 2020;
  - the development of imports, essentially of diesel, which we estimate, would be in the context presented above of the order of 50 Mt on top of the 50 Mt already existing (or a total of 100 Mt of imports out of a European diesel/heating oil consumption of 200 Mt at 2020). This type of development may affect jobs to an extent ranging from 25 to 30% (27.5% on the graph).
- the fourth scenario will combine scenario 2 and the increasing development of petroleum product imports to European specifications (scenario 3).

In total, the level of refining jobs could move negatively between 2015 and 2020, going from around 120,000 jobs in 2010-2012 to 72,000 jobs in 2020 (-40%) depending on the scenario.

This evolution could probably be realised slowly taking into account the positions affected by retirements and not refilled.

Prospects beyond 2020

Beyond 2020, the prospects of the European refining sector are very difficult to make out, in both the industrial contents of the sector as in the employment prospects, inasmuch as technological developments or breakthroughs could take effect.

The majority of possible developments which may affect refining are known but are characterised by incomplete technological mastery and cost levels too high to move to large-scale industrial application.

From this point of view, and in no particular order of importance, we may mention CO_2 storage and capture, GTL (gas-to-liquid) or CTL (coal-to-liquid) refining, the development of alternative fuels like CNG (compressed natural gas), biofuels and in particular biogas, and, of course, hydrogen. Lastly, the evolution of engines could, beyond 2020, play a central role.

Fig. III.11. : Employment in refineries at the horizon 2020 (thousands)

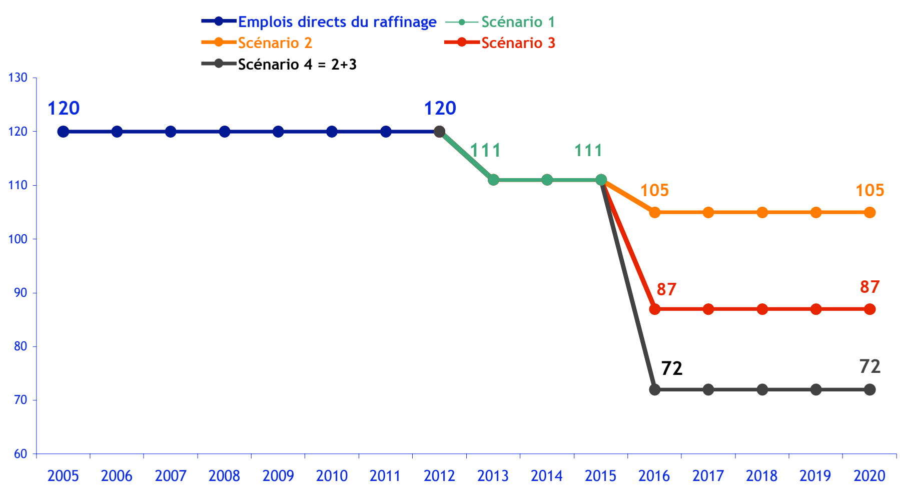


Figure III.12. : EU-25 performance by mode of freight transport
1995-2004
billion tonne-kilometres

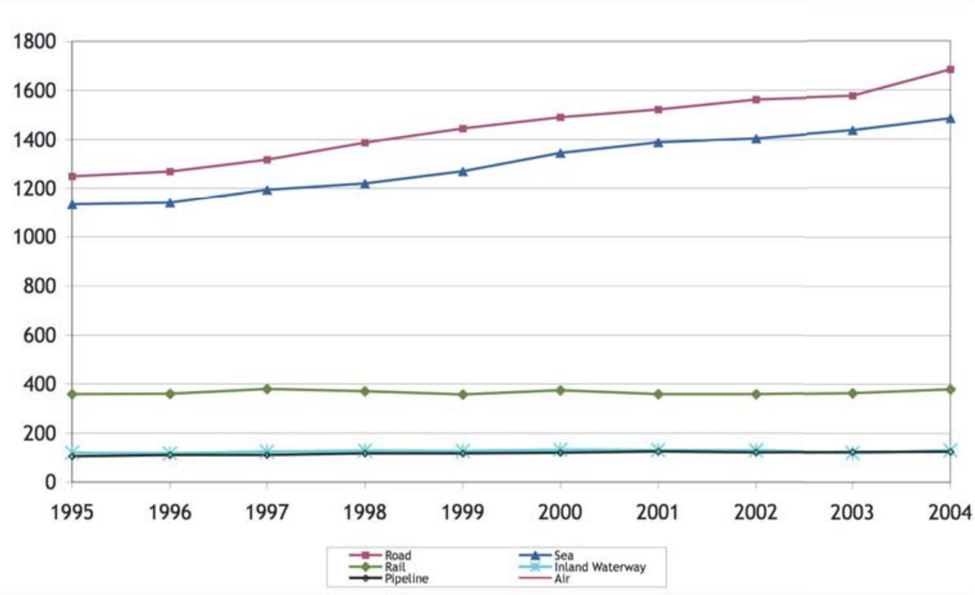
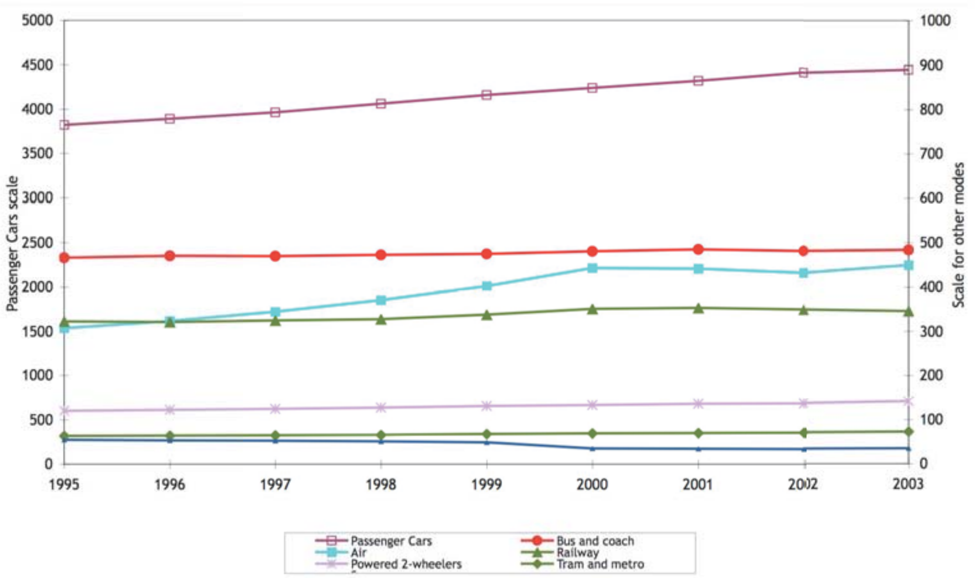


Figure III.13. :EU-25 Performance by mode for passenger transport
1995-2003
billion passenger – kilometres



Source: *Eurostat, European Conference of Ministers of Transport (ECMT), national statistics*

3. Transport

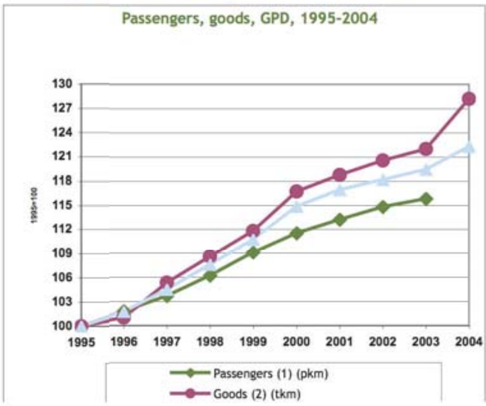
3.1. Activity and employment analysis

Overview

Over the period 1995-2004, goods transport advanced at an average annual rate of 2.8% and passenger transport by 2.8%, while GDP increased by 2.3%.

Since 1995, the volume of goods transported has experienced growth which almost parallels that of the GDP.

Fig. III.14.: Transport Growth in EU-25



Notes :
(1) : Passengers cars, powered two wheelers, busses and coaches, tramways et metros, railways, air, sea
(2) : road, sea, rail, waterways, pipelines, air
PIB : à prix constants de 1995 et taux de change

Annual growth rate - EU-25

PIB à prix constants	1995-2004 p.a.	2.3 %	2003-2004	2.4 %
Transport de passagers pkm	1995-2003 p.a.	1.9 %	2002-2003	0.9 %
Transport de marchandises tkm	1995-2004 p.a.	2.8 %	2003-2004	5.1 %

Note *: La forte croissance du transport de marchandises entre 2003 et 2004 est en partie due à un changement méthodologique dans la collecte des statistiques dans certains pays de l'UE.

Source: European Commission (Directorate-General for Energy and Transport)

Goods transport

The production of goods transport, **all modes combined**, and within the EU-25, is established at 3,804 billion tkm[43] in 2004, or an increase of 28% compared with 1995 and a mean average growth rate of 2.8% over this period.

Road transport represents 44.3% of this, sea 39%, rail 10%, inland waterways 3.4%, pipelines 3.3% and air 0.1%.

Table III.12.: Modal split (%)

	Road	Rail	Inland water-ways	Pipe-lines	Sea	Air
1995	42,1	12,1	4,0	3,6	38,2	0,1
1996	42,3	12,0	3,9	3,7	38,0	0,1
1997	42,1	12,1	4,0	3,5	38,2	0,1
1998	43,0	11,5	3,9	3,6	37,9	0,1
1999	43,5	10,8	3,8	3,5	38,3	0,1
2000	43,0	10,8	3,8	3,4	38,8	0,1
2001	43,2	10,2	3,7	3,5	39,4	0,1
2002	43,7	10,0	3,6	3,4	39,3	0,1
2003	43,5	10,1	3,3	3,4	39,6	0,1
2004	44,3	10,0	3,4	3,3	39,0	0,1

Sources : Eurostat, European conference of Ministers of transport (ECMT), national statistics

If we confine ourselves to **land transport** (table below), the share taken up by road transport is then, in 2004, 72.6%, followed by rail 16.4%, inland waterways 5.6% and pipelines 5.4%.

Table III.13.: Modal Split (%)

	Road	Rail	Inland Water-ways	Pipe- lines
1995	68,1	19,6	6,5	5,8
1996	68,4	19,4	6,3	6,0
1997	68,2	19,7	6,4	5,7
1998	69,3	18,5	6,3	5,9
1999	70,6	17,5	6,2	5,7
2000	70,5	17,7	6,2	5,6
2001	71,3	16,8	6,1	5,8
2002	72,0	16,5	5,9	5,6
2003	72,2	16,7	5,5	5,7
2004	72,6	16,4	5,6	5,4

[43] tkm = 1 tonne of goods transported over 1 kilometre.

Table III.14. : Employment by mode of transport

	Road Freight	Road passengers	Sea transport	Air transport
BE	*62 538*	*31 899*	*537*	*5 520*
CZ	100 338	51 795		5 340
DK	38 673	*30 504*	13 242	11 675
DE	275 207	279 526	17 089	51 471
EE	12 057	6 387		562
EL				
ES	348 876	161 639	7 299	37 699
FR	333 423	210 713	13 122	73 626
IE	15 658	*8 100*		
IT	329 413	141 480	21 277	24 850
CY	2 557	2 188	3 435	2 434
LV	11 851	14 977	366	608
LT	25 983	19 401	1 745	1 002
LU	*6 500*	*1 844*	*437*	*3 081*
HU	66 875	54 082	10	3 810
MT	*811*	*1 473*	*734*	*2 279*
NL	114 734		*6 889*	
AT	57 549	42 615	10	7 583
PL			*2 443*	
PT	60 178	38 760	835	8 785
SI	17 184	4 952	164	595
SK	9 218	17 362	*0*	342
FI	41 302	24 108	8 187	8 298
SE	61 424	49 751	13 243	12 538
UK	311 904	209 841	14 074	89 948
BG	49 650			*3 184*
RO	57 511	68 758		

Source : Eurostat (economic activity according to NACE Rev.1 classification)

Note : figures in italic : 2002 for LU, MT, IE, PL, SK; 2001 for BE, DK, NL, SE and BG

	Railway	inland water transport	Pipelines	travel agencies and tour operators	Other auxiliary transport activities
BE		*735*		*8 532*	*39 443*
CZ		*1 142*		12 452	28 713
DK	8 230	123		5 411	25 583
DE	87 752	9 034	511	61 934	409 134
EE	3 917		0	1 541	9 306
EL					
ES	36 788	247	0	47 358	150 175
FR		3 325		45 035	256 795
IE					*10 993*
IT	73 814	2 902	3 015	42 830	288 205
CY	0	0	0	2 703	4 680
LV	15 611	17	389	1 321	14 831
LT		120	0	1 810	11 616
LU	*3 249*	*1 212*	*0*	*658*	*1 688*
HU	55 129	1 502	8	6 024	23 753
MT	*0*	*0*	*0*	*1 771*	*3 317*
NL		13 264	137	21 947	65 410
AT	48 900	331	106	12 789	26 141
PL					*61 460*
PT		969		7 862	29 848
SI	8 544	27	0	2 336	6 716
SK		911		2 520	7 320
FI	8 668	254	0	5 093	19 579
SE	8 560	1 019	*21*	12 440	42 565
UK	48 396	2 135	368	136 665	244 571
BG		939		5 188	34 774
RO		4 272		5 515	34 764

Source : Eurostat (economic activity according to NACE Rev.1 classification)

Passenger transport

The production of passenger transport is established at 5,970 billion p-km[44] in 2003, or +15.8% compared with 1995 and an average annual growth rate of 1.4% over the course of the period 1995-2003.

The share taken up by the car represents 74.4%, a long way ahead of buses and coaches (8.1%), air (7.5%) and rail (5.8%).

Taking account only of land transport (table below), the share taken up by the car is even greater (83.2%), ahead of buses and coaches (9%), rail (6.5%) and tram & metro (1.4%).

Table III.15. : EU-25 Modal Split of Land Transport by country
Passenger Transport
Year 2003 – passenger-km in %

	Cars	Busses and coaches	railway	Tram & Metro
BE	82,8	10,3	6,2	0,7
CZ	73,7	10,1	7,0	9,2
DK	80,4	11,9	7,7	0,1
DE	84,8	6,7	7,1	1,5
EE	79,5	18,2	1,4	0,8
EL	71,5	25,1	1,8	1,6
ES	82,3	11,7	4,6	1,3
FR	85,4	4,9	8,3	1,3
IE	74,8	20,2	5,0	-
IT	82,7	11,4	5,3	0,7
CY	82,3	17,7	-	-
LV	73,2	18,7	5,6	2,5
LT	86,5	11,5	1,9	-
LU	82,3	14,1	3,6	-
HU	59,6	24,0	13,2	3,2
MT	90,0	10,0	-	-
NL	86,5	4,4	8,2	0,9
AT	75,9	13,8	7,7	2,6
PL	76,1	13,2	8,7	2,0
PT	86,9	9,4	3,0	0,7
SI	89,4	6,1	4,5	-
SK	70,7	21,9	6,5	0,9
FI	83,8	10,8	4,7	0,7
SE	81,7	8,9	7,7	1,7
UK	87,5	6,1	5,3	1,1
EU-25	83,2	9,0	6,5	1,4
EU-15	84,1	8,4	6,3	1,2

[44] pkm = 1 passenger transported over 1 kilometre.

Intermodal transport

The development of intermodal transport, whether combining road with sea, rail or river transport, is considered by the European Commission as an alternative to end-to-end road transport and one of the solutions to reducing greenhouse gas emissions generated by the transport sector (White Paper 2001; revision of White Paper in 2006).

The European Union is developing its own policy of support for intermodality, complementing national policies, even though no directive has been devoted to it. The Marco Polo programme, however, only has access to limited means, while the nodes of the networks, the intermodal depots, do not figure explicitly in the Trans-European Transport Networks promoted by the EU. Finally, railway interoperability remains very incomplete and obstructs development of rail and, *a fortiori*, road/rail transport.

The report of the Observatory on Transport Policies and Strategies in Europe on intermodality[45] considers the situation and the dynamics of intermodal transport in Europe as "somewhat contradictory". Countries and operators experiencing a growth in traffic rub shoulders with those who are going backwards. Governments invest in projects and in new capacity while their neighbours, even while proclaiming their desire for a balance between modes, reduce their subsidies and diminish their intermodal traffic.

Success in some countries or on some lines shows, however, that intermodal solutions can find what it takes to succeed in Europe. For all that, combined transport cannot reduce by more than a relatively modest percentage the greenhouse effect produced by transport.

Employment in transport

In 2003, the transport sector employed about 7.5 million people in the European Union of 25.

Of these 61% work in land transport (road, rail, river), 2% in sea transport, 5% in air transport, and around 1/3 (32%) in supporting or auxiliary transport activities (such as maintenance, storage and warehousing, travel and transport agencies, tour operators).

Five countries share nearly 70% of transport employees. These are:

- Germany: 17 %
- United Kingdom: 15 %
- France: 13 %
- Italy: 13 %
- Spain: 11 %

In the road-freight sector, employment has increased regularly in the past, carried along by the dynamics of economic growth.

On the other hand, the decline in rail traffic and the enterprise restructurings which followed regulatory reforms have led to a large reduction in employment in the rail sector, going from 1.8 million jobs in 1970 to around 770,000 jobs in 2000 for the 15 old Member States, with a sharply reduced rated of decrease in the last few years (760,000 in 2004). If employment seems to be able to be stabilised in the railway sector in the coming years, particularly in the old Member States, the trend should continue in the new Member States.

The transport sector in general employs relatively few young people and many older workers. In particular we observe the prevalence of aging workers in most countries, particularly in Italy, Greece, Spain, the United Kingdom and

45 Observatory on Transport Policies and Strategies in Europe, "Le transport intermodal en Europe", dossier 7, June 2005

Denmark, where more than 40% of the waged population working in the sector is aged over 44. This should worsen the shortage of workers prepared to work in road transport observed by several European countries. On the other hand, in certain new Member States, such as Poland, the availability of labour feeds road transport and reinforces its competitiveness.

Generally speaking, because of the working conditions, which cannot always be reconciled with family life, the proportion of women employed in freight transport, and particularly as drivers, is small and remains stable.

3.2. Greenhouse gas emissions

Transport is responsible for 26% of greenhouse gas emissions in 2003. These emissions increased by 26% between 1990 and 2003.

84% of these emissions come from road transport (+25% between 1990 and 2003) 13% from air (+55% between 1990 and 2003), 2% from river (-15% between 1990 and 2005) and 1% from rail (-33% from 1990 to 2005).

3.3. Scenarios which still seem to favour road transport....

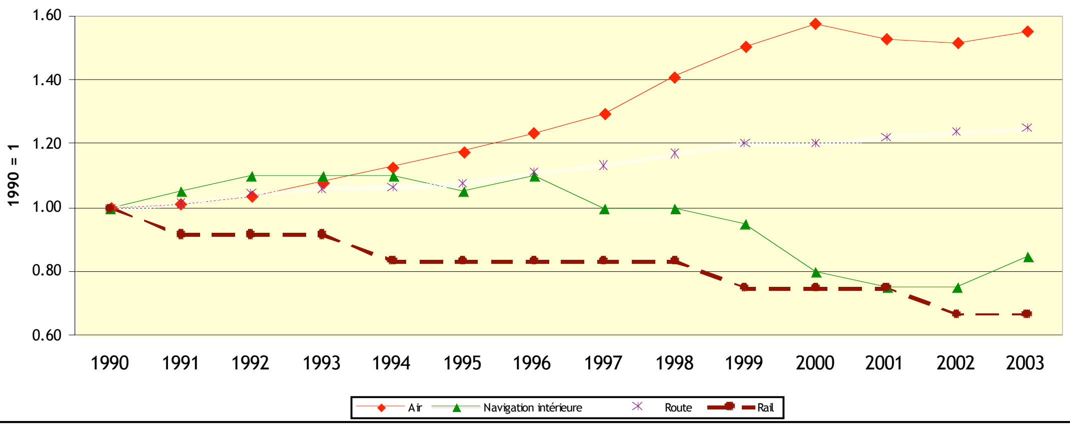
Two scenarios have been selected starting from the projections carried out by the Commission's DG-TREN for the 2001 White Paper. These are the 2005 reference scenario ("Business As Usual", BAU) and the "Extended Policy" scenario, which is the one which, compared with the BAU scenario, leads to the greatest reduction in CO_2. In addition, two variants of the "Extended policy" scenario have been constructed to analyse the impact of lowered passenger and freight activity and road/rail rebalancing.

2005 reference scenario (BAU)

This takes account of demographic changes, recent economic growth, which has been less than dynamic, and high energy prices.

It also takes account of polices and measures adopted by each Member State of the EU of 25, as well as renewable energies.

Fig. III.15 : Evolution of $C0_2$ transport emissions



Hypotheses made in this scenario include:

- pursuit of economic reform policies (Lisbon strategy),
- full realisation of the internal energy market,
- energy efficiency and renewable energies,
- the targets for CO_2 reduction set by automobile manufacturers are achieved,
- progressive closures of nuclear stations in some member countries as planned,
- CO_2 price of ¾5 per tonne,
- weaker economic growth (2% until 2030).
- slight progression of population between now and 2020, which will be more or less stagnant thereafter, price of a barrel of petroleum ¾55 (in 2005) and ¾95 in 2030 with inflation at 2%.

Share of transport in final energy demand

The predominant role of the transport sector in the growth in final energy demand is confirmed at the 2010 horizon (+1.4% per annum).

After 2010, the decoupling of transport activity from GDP growth and technical progress lead to a slow-down in demand growth between 2010 and 2020 (+0.8% per year) and even to a lowering in energy needs in the following period, 2020-2030 (-0.1%).

Thus, compared with 1990, transport would record, in 2030, the third-strongest growth with +20.8%, after residential (+28.5%) and tertiary (+41.7%). Manufacturing would record +18.6%.

In 2030, transport in the EU-25 should represent 30% of the final energy demand, i.e. still the largest share.

CO_2 emissions

The growth in CO_s emissions is to slow down by 2030, and even become negative after that.

This trend is explained by technological progress, the decoupling of transport activity from economic growth and the increasing penetration of biofuels mixed with petrol and diesel fuel.

In 2030, CO_2 emissions in transport should be 12.7% higher than those of 2000 and represent 27.6% of total emissions as against 26.4% in 2000.

Findings

For passenger activity, strong growth in aviation activity leading to an increase in its share in total transport – Continued preponderance of the personal vehicle at close to 80%

Between 2000 and 2030, passenger activity should undergo overall growth of 48.7%. In detail, it can be broken down as follows:

- Aviation: +152.5 %
- Private vehicles and motorcycles: +49.5 %
- Inland navigation: +47.3 %
- Rail: +25.6 %
- Passenger road transport: -2.8%

Compared with 2000, the relative share of each of these modes of transport is modified in 2003. Thus:

- It would stagnate for private cars (78%) and inland navigation (0.6%)
- For aviation it would increase from 6.3% to 9.2%
- It would diminish slightly for rail (6.2% as against 7.2%) and more strongly for public road transport (8.2% to 5.7%).

For goods activity, strong growth in lorries whose share will be bolstered at the expense of rail and inland navigation

Between 2000 and 2030, activity would advance very strongly for lorries (+78.8%), and to a lesser extent for inland navigation (+23.8%) and rail (+17.3%).

Because of this, the share of lorries in overall activity would go up (from 69.7% to 77.4%), while those of rail (from 17.6% to 12.8%) and inland navigation (from 12.7% for 9.8%) would diminish.

For energy demand, strong progress for lorries, which should represent around 40%

of final demand in 2030, like public passenger transport.

It would increase overall by 20.8% between 2000 and 2030.

It would grow between 2000 and 2030 for:

- Lorries (+52.1%). They would then represent 40.9% of final demand in 2030 as against 32.5% in 2000.
- Aviation (+33,2%) and inland navigation (+18.3%). Their respective shares would remain relatively stable over the period.

It would drop for public passenger transport (-24.2%) and rail (-32.3%) and would stagnate for private vehicles. Their relative shares would also diminish.

Road, with lorries and private vehicles, would remain a major consumer with more than 80% of the energy demand of the transport sector.

Extended policy scenario

This scenario is the one which most closely approaches Option C in the White Paper on "European transport policy for 2010: time to decide", with a growth in emissions between 1998 and 2010:

- +1% for passenger transport
- + 26% for freight transport
- +10% for total transport

In 2010, the share of rail and public road transport would return to the level of 1998.

These modes of transport are therefore going to grow more strongly than in the BAU scenario, while the other modes of transport would experience no change in their volumes compared with the level of the BAU scenario. These other modes of transport therefore grow more slowly than in the BAU scenario.

In this scenario, the filling capacity of all modes of transport would increase significantly up to 2010 in relation to the trends in the base scenario. This means that all modes of transport would be used more efficiently.

This "Extended Policy" scenario is considered to be that which involves practically all the measures that can be implemented between now and 2010 to limit energy consumption and CO_2 emissions of means of transport.

This scenario makes the following hypotheses:

- Strong penetration at 2020/2030 of natural gas, biofuels and hydrogen. In the BAU scenario, the transport sector remains heavily dependent on liquid fuels
- Major efforts to develop TEN-T infrastructures as well as those necessary for new fuels such as hydrogen and methanol. Similarly, the hypotheses assume the development of new automobile technologies such as the natural-gas vehicle.
- Incorporation of the 2003 directive on the taxation of energy products and electricity. It will only be taken into account after 2010 to allow for the implementation delay in the various Member States.
- A CO_2 price of ³⁄12/t in 2010, ³⁄16/t in 2015 and ³⁄20/t in 2020 and onwards.

CO2 emissions

In 2030, CO_2 emissions in transport should be 10% higher than those of 1990 but 10% less than in 2000.

Findings

For passenger activity (in Gpkm): strong increase in activity in aviation causing an increase in its share of overall activity. The private car would still represent ¾ of the activity.

Total activity would increase by 32.8% between 2000 and 2030, or less than the increase described in the BAU scenario. All modes of transport would be affected by an increase in their activity. This would be even more pronounced than in the BAU scenario for public transport and for rail.

As a result, the aviation's share would increase from 5.4% to 9.7% (more than in the BAU scenario). The shares of public transport and private vehicles would lower, while that of inland navigation would stagnate (0.6%).

For goods activity (in Gtkm): lorries would go up strongly, representing an ever-increasing share of goods activity

The activity of lorries would double between 2000 and 2030. There would also be sustained growth for rail (+53.8%) and inland navigation (+68.2%). Overall, total activity would increase by 88.1% (+61% in the BAU scenario).

The share of lorries would increase, while those of rail and inland navigation would reduce.

The difference relates to the demand for energy

Total demand would only increase, in fact, by 6.6% (between +17% and +23% in the previous scenarios).

The demand would decrease for:

- passenger public transport: –11.4 %
- private vehicle: –14.7 %
- rail: –26.7 %

It would increase for:

- lorries: +40 %
- inland navigation: +44.4 %
- aviation: +4.7 %

The structure of demand changes between 2000 and 2030. The shares for public passenger transport, private vehicles and rail diminish, while that for lorries and inland navigation increases.

For aviation, the share would be 13.3% (13.6% in 2000), after reaching its lowest level in 2010 at 10.4%.

Two variants of "Extended Policy" scenario: lowered activity and road/rail rebalancing

On the basis of the "Extended Policy" scenario we have constructed two variants:

A scenario entitled "Extended policy - Lower freight activity"

For passenger transport, the hypothesis is a lowering of private road transport activity by 10% in 2010, 20% in 2020 and 25% in 2030 in comparison with the "Extended Policy" scenario, compensated by an increase in public road and rail transport.

For freight transport: an overall lowering of freight activity by 5% in 2010, 11% in 2020 and 15% in 2030, and a rebalancing of rail in relation to road taking the share of rail to 20% in 2010 as against 18% for the "Extended Policy" scenario, 25% in 2020 as against 16% for the "Extended Policy" scenario, and 26% in 2030 as against 14% for the "Extended Policy" scenario. Thus the share of rail would be returned to its 1990 level.

In this "Extended policy - Lower Activity" scenario, CO_2 emissions may be estimated at 845.5 Mt at the 2030 horizon, or an increase of 7% compared with 1990 (compared with 10% in the BAU scenario) and a reduction of 13% compared with the year 2000 (as against 10% for the "Extended Policy" scenario).

CO_2 emissions (Mt)	1990	2000	2010	2020	2030
Sc. Extended policy	792,7	969,9	860,9	840,4	871,8
Sc. Extended policy lower activity	792,7	969,9	852,2	829,2	845,5

This scenario supposes, as proposed by several environmental NGOs, a policy of rebalancing in favour of public transport in the passenger transport area, a correction of distortions due to regional planning policies that have led to a major expansion of urban zones without regard to the consequences in the area of travel and energy efficiency. The armoury of tools is broad, and goes from the policy of localisation of activities to the control of urbanisation and from the planning of urban roadways to the evaluation of planning policy.

For freight, this scenario implies a policy joining development of intermodality (road-rail), better flow management and reduction of distances (produce locally for a local market).

Finally, by a fiscal policy (fuel tax) automatically benefiting alternatives to road transport, which are much less thirsty per t.km than road. In this regard, the Swiss example is interesting since this country has chosen to introduce a single 96 duty, applicable for all lorries but proportional to the distance travelled. Thus, short-distance road transport, often an essential fulcrum of the local social economy, is not penalised, unlike long-haul drivers, who often find it in their financial interest to take the train. Germany has introduced a similar tax, but only on motorways.

A scenario entitled 'Extended policy - Lower freight and passengers activity"

This scenario supposes a lowering of passenger transport activity of 8% at the 2030 horizon compared with the "Extended Policy" scenario, in addition to the 15% reduction of freight activity in the preceding scenario.

Emphasising policies that favour a reduction in private passenger transport, within the technological hypotheses of the "Extended Policy" scenario, leads to a reinforced reduction of CO_2 emissions, namely a 1,2% increase compared with the year 1990 and a 17% reduction of CO_2 emissions compared with the year 2000.

CO_2 emissions (Mt)	1990	2000	2010	2020	2030
Sc. Extended policy	792,7	969,9	860,9	840,4	871,8
Sc. Extended policy lower activity pass. And Freight	792,7	969,9	823,3	797,2	802,4

Conclusion: lack of visibility on long-term emissions reduction pathways

Without doubt, policies oriented towards an overall reduction in transport activity and a rebalancing towards public forms of transport (rail in particular, but also navigable waterways for freight) are apt to reduce not only CO_2 emissions but also external negative factors linked in particular to management of road axes.

However, these structural policies cannot suffice to achieve the aim of a voluntarist reduction of 40% in transport greenhouse gas emissions. The most voluntarist scenario leads to a stabilisation of emissions in 2030 at best.

In particular, the 2001 White paper objective in term of modal shift seems to raise important difficulties without a strong reduction of transport activity, as shown by the failure of all DG TREN scenario to achieve even a stabilisation of the share of rail transport and public road transport in 2010 compared with 1998 level.

The rapid spread of clean technologies highlights a strategic issue in this regard and supposes appropriate measures in the areas of financing research and development.

Table III.16. Share of rail and public road transport in various scenarios

	BAU		Extended Policy		Extended policy - lower freight activity		WWF/WI	
	2000	2030	2000	2030	2000	2030	2000	2030
total activity (en Gtkm)	7,597	11,562	7,597	12,568	7,597	10,586		
Part of rail and public road transport	23%	12%	17%	15%	17%	36%	16%	16%

Table III.17. : Passenger transport (billion pkm) : scenario Extended policy

Activités (Gpkm)	1990	2000	2010	2020	2030	Difference with Baseline 2010 Montant	2010 %	2020 Montant	2020 %	2030 Montant	2030 %	Variation 00-10	Variation 00-20	Variation 00-30
public road transport	504,1	480,1	559,2	594,6	623,4	64,2	13,0	114,0	23,7	156,7	33,6	79,1	114,5	143,3
Private cars and motocycles	3 529,3	4 253,1	4 922,7	5 684,3	6 379,9	-93,9	-1,9	-96,4	-1,7	21,3	0,3	669,6	1 431,2	2 126,8
Rail	411,9	402,7	500,2	578,3	650,7	53,8	12,1	99,8	20,9	145,1	28,7	97,5	175,6	248,0
Aviation	166,3	296,9	403,0	595,6	824,8	-48,6	-0,8	-21,1	-3,4	75,1	10,0	106,1	298,7	527,9
inlan navigation	29,2	33,6	39,3	45,8	53,3	-0,4	-1,0	0,3	0,7	3,8	7,7	5,7	12,2	19,7
TOTAL	4 640,8	5 466,4	6 424,4	7 498,6	8 532,1	-24,9	-0,4	96,6	1,3	402,0	4,9	958,0	2 032,2	3 065,7
travel per person (km per capita)	10 528	12 069	13 929	16 227	18 622	31,0	0,2	454,0	2,9	1300,0	7,5			
Activities (Structure)												00-10	00-20	00-30
public road transport	10,9%	8,8%	8,7%	7,9%	7,3%							16,5%	23,8%	11,5%
private cars and motocycles	76,0%	77,8%	76,6%	75,8%	74,8%							15,7%	33,7%	29,6%
Rail	8,9%	7,4%	7,8%	7,7%	7,6%							24,2%	43,6%	30,1%
Aviation	3,6%	5,4%	6,3%	7,9%	9,7%							35,7%	100,6%	104,7%
inland navigation	0,6%	0,6%	0,6%	0,6%	0,6%							17,0%	36,3%	35,6%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%							17,5%	37,2%	32,8%

Table III.18. : Freight transport (billion tkm) : scenario Extended policy

Activities(Gtkm)	1990	2000	2010	2020	2030	Difference with Baseline 2010 Montant	2010 %	2020 Montant	2020 %	2030 Montant	2030 %	Variation 00-10	Variation 00-20	Variation 00-30
trucks	1 034,1	1 486,3	1 851,1	2 378,3	2 975,2	-40,1	-2,1	66,6	2,9	317,8	12,0	364,8	892,0	1 488,9
Rail	461,7	374,2	462,2	516,5	561,6	60,2	15,0	95,1	22,6	122,7	28,0	88,0	142,3	187,4
Inland navigation	258,1	271,0	372,6	436,8	499,6	83,6	28,9	121,2	38,4	164,0	48,9	101,6	165,8	228,6
TOTAL	1 753,9	2 131,5	2 685,9	3 331,6	4 036,4	0,0	-0,1	-7,3	-0,2	-6,5	-0,2	554,4	1 200,1	1 904,9
Freight activity per unit of GDP (tkm / 1 000 € of 2000)	240	238	235	230	224	-4,0	-0,1	-1,0	-0,2	0,0	-0,2			
Activities(Structure)												00-10	00-20	00-30
Trucks	59,0%	69,7%	68,9%	71,4%	73,7%							24,5%	60,0%	100,2%
Rail	26,3%	17,6%	17,2%	15,5%	13,9%							23,5%	38,0%	50,1%
Inland navigation	14,7%	12,7%	13,9%	13,1%	12,4%							37,5%	61,2%	84,4%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%							26,0%	56,3%	89,4%

Table III.19. : Energy consumption (millions of tep) : scenario Extended policy

Activities	1990	2000	2010	2020	2030	Difference with Baseline 2010 Montant	2010 %	2020 Montant	2020 %	2030 Montant	2030 %	Variations 00-10	Variations 00-20	Variations 00-30
public and road transport	7,8	7,0	7,2	6,6	6,2	0,2	2,6	0,3	5,2	0,9	16,5	0,2	-0,4	-0,8
Private cars and motocycles	138,2	158,3	147,8	140,1	134,0	-22,4	-13,1	-28,8	-17,1	-25,9	-16,2	-10,5	-18,2	-24,3
Trucks	82,4	108,1	117,6	135,1	152,1	-18,0	-13,3	-21,7	-13,9	-12,3	-7,5	9,5	27,0	44,0
Rail	9,1	8,9	7,7	6,5	6,6	-0,6	-7,3	0,0	-0,3	0,6	9,7	-1,2	-2,4	-2,3
Aviation	28,9	45,3	33,1	39,6	47,2	-21,1	-38,9	-21,2	-34,8	-13,2	-21,8	-12,2	-5,7	1,9
Inland navigation	6,7	5,4	6,2	7,0	7,8	0,4	6,7	0,8	12,8	1,4	22,8	0,8	1,6	2,4
TOTAL	273,2	333,0	319,6	334,9	353,9	-61,5	-16,1	-70,6	-17,4	-48,4	-12,0	-13,4	1,9	20,9
part passengers	*182,4*	*218,1*	*194,0*	*192,0*	*192,8*	*-44,6*	*-18,7*	*-50,1*	*-20,7*	*-38,1*	*-16,5*			
and freigth	*90,7*	*114,9*	*125,4*	*143,3*	*160,6*	*-17,4*	*-12,16*	*-20,5*	*-12,5*	*-10,6*	*-6,2*			
Activities (Structure)												00-10	00-20	00-30
Public and road transport	2,9%	2,1%	2,3%	2,0%	1,8%							2,6%	-6,0%	-11,7%
Private cars and motocycles	50,6%	47,5%	46,2%	41,8%	37,9%							-6,7%	-11,5%	-15,4%
Trucks	30,2%	32,5%	36,8%	40,3%	43,0%							8,8%	25,0%	40,7%
Rail	3,3%	2,7%	2,4%	1,9%	1,9%							-13,5%	-26,9%	-25,8%
Aviation	10,6%	13,6%	10,4%	11,8%	13,3%							-27,0%	-12,6%	4,1%
Inland navigation	2,5%	1,6%	1,9%	2,1%	2,2%							15,5%	30,4%	45,3%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%							-4,0%	0,6%	6,3%
part passengers	*67%*	*65%*	*61%*	*57%*	*54%*									
and freigth	*33%*	*34%*	*39%*	*43%*	*45%*									

Indicateurs	1990	2000	2010	2020	2030	Différence avec Baseline 2010 Montant	2010 %	2020 Montant	2020 %	2030 Montant	2030 %	Variation 00-10	Variation 00-20	Variation 00-30
Emissions of CO_2 (Mt)	792,7	969,9	860,9	840,4	871,8	-213,7	-19,9	-275,1	-24,7	-221,1	-20,2	-109,0	-129,5	-98,1
Demande finale d'énergie (t de CO_2/tep)	2,90	2,91	2,69	2,51	2,46	-0,13	-4,5	-0,24	-8,8	-0,25	-9,3	-0,2	-0,4	-0,4
Passengers Transport (tep/Mpkm)	39,3	39,9	30,2	25,6	22,6	-6,8	-18,4	-7,1	-21,7	-5,8	-20,4	-9,7	-14,3	-17,3
Freight transport (tep/Mtkm)	51,7	53,9	46,7	43	39,8	-8,6	-15,6	-10,7	-19,9	-10,1	-20,2	-7,2	-10,9	-14,1

Table III.20. : passenger and goods transport (Gpkm)

Passengers

	Baseline Scénario							Promoting rail - load trans			Energy policy		
	2000	2005	2010	2015	2020	2025	2030	2010	2020	2030	2010	2020	2030
Activities (Gpkm)													
public road transport	480,1	484,4	495,0	487,5	480,6	474,4	466,7	560,0	595,6	624,2	505,4	535,8	560,6
Private cars and motocycles	4 253,1	4 580,5	5 016,6	5 408,2	5 780,7	6 090,1	6 358,6	4 922,4	5 686,1	6 380,3	5 027,0	5 791,7	6 483,4
Rail	402,7	422,0	446,4	462,3	478,5	493,7	505,6	503,2	581,3	654,1	413,7	478,0	536,3
Aviation	296,9	369,7	451,6	535,2	616,7	686,1	749,7	402,8	595,3	824,2	451,5	664,6	917,3
Inland navigation	33,6	36,4	39,7	42,6	45,5	47,8	49,5	39,3	45,7	53,2	40,4	46,9	54,4
TOTAL	5 466,4	5 893,0	6 449,3	6 935,8	7 402,0	7 792,1	8 130,1	6 427,7	7 504,0	8 536,0	6 438,0	7 517,0	8 552,0
travel per person (km)	12 069	12 843	13 898	14 842	15 773	16 577	17 322	13 936	16 239	18 631	13 959	16 267	18 666
Activities (Structure)													
public road transport	8,8%	8,2%	7,7%	7,0%	6,5%	6,1%	5,7%	8,7%	7,9%	7,3%	7,9%	7,1%	6,6%
Private cars and motocycles	77,8%	77,7%	77,8%	78,0%	78,1%	78,2%	78,2%	76,6%	75,8%	74,7%	78,1%	77,0%	75,8%
Rail	7,4%	7,2%	6,9%	6,7%	6,5%	6,3%	6,2%	7,8%	7,7%	7,7%	6,4%	6,4%	6,3%
Aviation	5,4%	6,3%	7,0%	7,7%	8,3%	8,8%	9,2%	6,3%	7,9%	9,7%	7,0%	8,8%	10,7%
Inland navigation	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

	Extended Policy			Full policy			Kyoto forever			Gothenburg type target		
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2010	2020	2030
Activities (Gpkm)												
public road transport	559,2	594,6	623,4	559,2	594,6	623,4	501,7	531,6	555,7	501,7	530,9	553,5
Private cars and motocycles	4 922,7	5 684,3	6 379,9	4 922,7	5 684,2	6 379,6	5 016,5	5 773,0	6 453,8	5 016,5	5 758,1	6 399,4
Rail	500,2	578,3	650,7	500,2	578,5	651,2	411,9	473,6	530,6	411,9	470,5	522,8
Aviation	403,0	595,6	824,8	403,0	595,6	824,8	444,8	649,6	890,6	444,8	636,7	845,2
Inland navigation	39,3	45,8	53,3	39,3	45,7	53,3	40,3	46,7	54,2	40,3	46,7	54,0
TOTAL	6 424,4	7 498,6	8 532,1	6 424,4	7 498,6	8 532,3	6 415,2	7 474,5	8 484,9	6 415,2	7 442,9	8 374,9
travel per person (km)	13 929	16 227	18 622	13 929	16 227	18 623	13 909	16 174	18 520	13 909	16 106	18 280
Activities (Structure)												
public road transport	8,7%	7,9%	7,3%	8,7%	7,9%	7,3%	7,8%	7,1%	6,5%	7,8%	7,1%	6,6%
Private cars and motocycles	76,6%	75,8%	74,8%	76,6%	75,8%	74,8%	78,2%	77,2%	76,1%	78,2%	77,4%	76,4%
Rail	7,8%	7,7%	7,6%	7,8%	7,7%	7,6%	6,4%	6,3%	6,3%	6,4%	6,3%	6,2%
Aviation	6,3%	7,9%	9,7%	6,3%	7,9%	9,7%	6,9%	8,7%	10,5%	6,9%	8,6%	10,1%
Inland navigation	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Freight

	Baseline Scénario							Promoting rail - load trans			Energy policy		
	2000	2005	2010	2015	2020	2025	2030	2010	2020	2030	2010	2020	2030
Activities (Gtkm)													
Trucks	1 486,3	1 655,9	1 891,2	2 098,8	2 311,7	2 499,5	2 657,4	1 850,5	2 378,7	2 974,2	1 967,6	2 515,9	3 129,9
Rail	374,2	386,8	402,0	413,8	421,4	431,4	438,9	465,6	520,4	565,9	377,2	418,0	451,0
Inland navigation	271,0	278,5	289,0	303,2	315,6	327,0	335,6	372,7	437,0	499,7	345,0	402,9	458,8
TOTAL	2 131,5	2 321,2	2 582,2	2 815,8	3 048,7	3 257,9	3 431,9	2 688,8	3 336,1	4 039,8	2 689,8	3 336,8	4 039,7
Freigth activity per unit of GDP (tkm/1000 euro	238	239	236	229	223	218	214	235	231	224	235	231	224
Activities (Structure)													
Trucks	69,7%	71,3%	73,2%	74,5%	75,8%	76,7%	77,4%	68,8%	71,3%	73,6%	73,2%	75,4%	77,5%
Rail	17,6%	16,7%	15,6%	14,7%	13,8%	13,2%	12,8%	17,3%	15,6%	14,0%	14,0%	12,5%	11,2%
Inland navigation	12,7%	12,0%	11,2%	10,8%	10,4%	10,0%	9,8%	13,9%	13,1%	12,4%	12,8%	12,1%	11,4%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

	Extended Policy			Full policy			Kyoto forever			Gothenburg type target		
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2010	2020	2030
Activities (Gtkm)												
Trucks	1 851,1	2 378,3	2 975,2	1 851,1	2 378,2	2 974,8	1 960,7	2 501,7	3 104,6	1 960,7	2 486,3	3 045,5
Rail	462,2	516,5	561,6	462,2	516,7	562,0	375,4	414,1	446,0	375,4	411,3	438,5
Inland navigation	372,6	436,8	499,6	372,6	436,8	499,5	343,2	400,3	455,2	343,2	398,8	450,1
TOTAL	2 685,9	3 331,6	4 036,4	2 685,9	3 331,7	4 036,3	2 679,3	3 316,1	4 005,8	2 679,3	3 296,4	3 934,1
Freigth activity per unit of GDP (tkm/1000 euro	235	230	224	235	230	224	234	229	222	234	228	218
Activities (Structure)												
Trucks	68,9%	71,4%	73,7%	68,9%	71,4%	73,7%	73,2%	75,4%	77,5%	73,2%	75,4%	77,4%
Rail	17,2%	15,5%	13,9%	17,2%	15,5%	13,9%	14,0%	12,5%	11,1%	14,0%	12,5%	11,1%
Inland navigation	13,9%	13,1%	12,4%	13,9%	13,1%	12,4%	12,8%	12,1%	11,4%	12,8%	12,1%	11,4%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Table III.21. : energy consumption (Mtep) – Base Scenario

	Baseline Scénario							Promoting rail - load trans			Energy policy		
	2000	2005	2010	2015	2020	2025	2030	2010	2020	2030	2010	2020	2030
Activities													
Public road transport	7,0	7,0	7,0	6,7	6,3	5,8	5,3	7,4	7,4	7,0	7,0	6,4	5,8
Private cars and motocycles	158,3	169,3	170,2	164,4	168,9	166,5	159,9	150,6	148,9	142,3	166,0	159,8	150,7
Trucks	108,1	119,8	135,6	148,4	156,8	162,4	164,4	120,3	151,3	181,5	142,2	157,7	165,4
Rail	8,9	8,9	8,3	7,2	6,5	6,2	6,0	8,4	7,4	7,4	7,4	5,8	5,6
Aviation	45,3	50,0	54,2	57,5	60,8	58,9	60,4	43,9	54,8	63,6	40,6	46,0	53,6
Inland navigation	5,4	5,6	5,8	6,0	6,2	6,3	6,4	6,3	7,2	8,2	6,2	6,9	7,4
TOTAL	333,0	360,6	381,1	390,3	405,5	406,1	402,3	336,9	377,0	410,0	369,4	382,6	388,5
part of passengers	*218,1*	*234,0*	*238,6*	*235,1*	*242,0*	*236,9*	*230,9*	*208,9*	*216,9*	*219,4*	*219,5*	*217,2*	*215,5*
and freight	*114,9*	*126,7*	*142,8*	*155,4*	*163,7*	*169,4*	*171,3*	*128,3*	*159,8*	*190,7*	*149,8*	*165,2*	*173,3*
Activities (Structure)													
Public road transport	2,1%	1,9%	1,8%	1,7%	1,5%	1,4%	1,3%	2,2%	2,0%	1,7%	1,9%	1,7%	1,5%
Private cars and motocycles	47,5%	46,9%	44,7%	42,1%	41,7%	41,0%	39,7%	44,7%	39,5%	34,7%	44,9%	41,8%	38,8%
Trucks	32,5%	33,2%	35,6%	38,0%	38,7%	40,0%	40,9%	35,7%	40,1%	44,3%	38,5%	41,2%	42,6%
Rail	2,7%	2,5%	2,2%	1,9%	1,6%	1,5%	1,5%	2,5%	2,0%	1,8%	2,0%	1,5%	1,4%
Aviation	13,6%	13,9%	14,2%	14,7%	15,0%	14,5%	15,0%	13,0%	14,5%	15,5%	11,0%	12,0%	13,8%
Inland navigation	1,6%	1,5%	1,5%	1,5%	1,5%	1,6%	1,6%	1,9%	1,9%	2,0%	1,7%	1,8%	1,9%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
part of passengers	*65%*	*65%*	*63%*	*60%*	*60%*	*58%*	*57%*	*62%*	*58%*	*54%*	*59%*	*57%*	*55%*
and freight	*34%*	*35%*	*37%*	*40%*	*40%*	*42%*	*43%*	*38%*	*42%*	*47%*	*41%*	*43%*	*45%*

	Baseline Scénario												
Indicators	2000	2005	2010	2015	2020	2025	2030	2010	2020	2030	2010	2020	2030
Emissions of CO_2 (Mt)	969,9	1 038,8	1 074,6	1 087,0	1 115,5	1 108,1	1 092,9	962,1	1 065,9	1 144,4	1 005,3	1 039,1	1 054,8
Demande finale d'énergie (t de CO_2/tep)	2,91	2,88	2,82	2,78	2,75	2,73	2,72	2,86	2,83	2,79	2,72	2,72	2,72
passengers transport (tep/Mpkm)	39,9	39,7	37,0	33,9	32,7	30,4	28,4	32,5	28,9	25,7	34,1	28,9	25,2
Freight Transport (tep/Mtkm)	53,9	54,6	55,3	55,2	53,7	52	49,9	47,7	47,9	47,2	55,7	49,5	42,9

	Extended Policy			Full policy			Kyoto forever			Gothenburg type target		
	2010	2020	2030	2010	2020	2030	2010	2020	2030	2010	2020	2030
Activities												
Public road transport	7,2	6,6	6,2	7,2	6,6	6,2	7,1	6,8	6,1	7,1	6,7	5,8
Private cars and motocycles	147,8	140,1	134,0	147,8	140,1	134,0	168,3	167,1	157,6	168,3	166,0	153,9
Trucks	117,6	135,1	152,1	117,6	135,1	152,1	143,2	169,5	186,5	143,2	165,2	173,0
Rail	7,7	6,5	6,6	7,7	6,5	6,6	7,7	6,1	5,9	7,7	6,0	5,6
Aviation	33,1	39,6	47,2	33,1	39,6	47,2	47,9	55,1	61,3	47,9	49,3	48,9
Inland navigation	6,2	7,0	7,8	6,2	7,1	7,8	6,2	7,0	7,6	6,2	7,0	7,4
TOTAL	319,6	334,9	353,9	319,6	335,0	353,9	380,4	411,6	425,0	380,4	400,2	394,6
part of passengers	*194,0*	*192,0*	*192,8*	*194,0*	*192,0*	*192,8*	*229,7*	*234,7*	*229,9*	*229,7*	*227,0*	*213,6*
and freight	*125,4*	*143,3*	*160,6*	*125,4*	*143,3*	*160,6*	*150,8*	*177,4*	*194,7*	*150,8*	*173,1*	*181,0*
Activities (Structure)												
Public road transport	2,3%	2,0%	1,8%	2,3%	2,0%	1,8%	1,9%	1,7%	1,4%	1,9%	1,7%	1,5%
Private cars and motocycles	46,2%	41,8%	37,9%	46,2%	41,8%	37,9%	44,2%	40,6%	37,1%	44,2%	41,5%	39,0%
Trucks	36,8%	40,3%	43,0%	36,8%	40,3%	43,0%	37,6%	41,2%	43,9%	37,6%	41,3%	43,8%
Rail	2,4%	1,9%	1,9%	2,4%	1,9%	1,9%	2,0%	1,5%	1,4%	2,0%	1,5%	1,4%
Aviation	10,4%	11,8%	13,3%	10,4%	11,8%	13,3%	12,6%	13,4%	14,4%	12,6%	12,3%	12,4%
Inland navigation	1,9%	2,1%	2,2%	1,9%	2,1%	2,2%	1,6%	1,7%	1,8%	1,6%	1,7%	1,9%
TOTAL	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
part of passengers	*61%*	*57%*	*54%*	*61%*	*57%*	*54%*	*60%*	*57%*	*54%*	*60%*	*57%*	*54%*
and freight	*39%*	*43%*	*45%*	*39%*	*43%*	*45%*	*40%*	*43%*	*46%*	*40%*	*43%*	*46%*

Indicators	2010	2020	2030	2010	2020	2030	2010	2020	2030	2010	2020	2030
Emissions of CO_2 (Mt)	860,9	840,4	871,8	860,9	840,4	871,7	1 090,8	1 168,8	1 190,5	1 090,8	1 134,9	1 102,8
Demande finale d'énergie (t de CO_2/tep)	2,69	2,51	2,46	2,69	2,51	2,46	2,87	2,84	2,80	2,87	2,84	2,79
passengers transport (tep/Mpkm)	30,2	25,6	22,6	30,2	25,6	22,6	35,8	31,4	27,1	35,8	30,5	25,5
Freight Transport (tep/Mtkm)	46,7	43	39,8	46,7	43	39,8	56,3	53,5	48,6	56,3	52,5	46

3.4. Modelling the effects on jobs resulting from greenhouse-gas reduction policies in transport

To get a handle on the employment dynamics resulting from greenhouse-gas reduction policies, we used the methodological tool developed by ECOTEC in the study it conducted for the Friends of the Earth in Great Britain in 1997[46]: This study is to this day the most complete in measuring the employment effects linked to the implementation of sustainable-development transport policies.

In this study three types of scenario are envisaged, concerning only passenger transport, having a goal of a reduction of 10% by 2010 in comparison with 1999. A base scenario built around an evolution of modes of transport: principally more public transport and secondarily use of bicycles and walking at the expense of private transport. A technological scenario in which "clean" technologies penetrate motorised transport: 10% CNG, 15% for new low-emission petrol and diesel fuels, and 5% electric vehicles essentially for urban usage. A third scenario, a mix of the second with a major development of modalities of vehicle hire at the expense of the fleet of private vehicles. The table below summarises the employment effects, in Great Britain, of each of the scenarios.

Table III.22.: Estimate of the direct employment impact of the STS (jobs)

Scenarios	car-based industries	Cycles, bus and rail industries	Net effect
Baseline STS	- 43 000	+ 130 000	+ 87 000
High technology take-up	- 23 000	+ 130 000	- 107 000
Combined high-tech, high lease	- 8 000	+ 130 000	+ 122 00

Source ECOTEC

The main lesson of this study relates, to a greater or lesser extent depending on the scenarios, on positive effects from the point of view of employment of the implementation of sustainable development policies in transport.

The evaluation of the employment effects carried out by ECOTEC rests on technical ratios detailed in the table below.

Table III.23. : Technical ratio of passenger transport

Nb of jobs per billion of pkm	Baseline	Scénario de transport durable	Haute technologie
car jobs	1 858	1 990	2 041
bus jobs		1 047	
rail jobs		3 448	

Source: Ecotec

Nb of jobs per billion of pkm	Baseline	Scénario de transport durable	Haute technologie
bus jobs		2 890	
rail jobs		1 185	

Source : DG Tren

For the car, the technical ratios take into account the whole of the automobile branch: automobile manufacturers, suppliers, associated services (fuel distribution, repairs, etc.), infrastructure and all inputs (materials and fuels). This technical ratio changes between the Base Line scenario and High Technology primarily as a function of the changing technological mix in the motor transport field[47].

For road and rail public transport, the ratio takes into account not only jobs induced in the construction and repair of material but also jobs induced by investments in infrastructure. We have complemented this evaluation carried out by ECOTEC by including jobs linked to the transport services themselves (employment in transport businesses), on the basis of the 2005 statistics from DG TREN.

[46] Less Traffic, More Jobs: The Direct Employment Impacts of Developing a Sustainable Transport System in the United Kingdom. Commissioned by Friends of the Earth

[47] 10% natural gas, 5% penetration for the electric vehicle, 11% penetration for the hybrid vehicle at 2010 horizon (of new acquisitions).

For freight, we used DG TREN's statistics on numbers of direct employees linked to road and rail transport which we increased in order to take account of indirect employees (rolling-stock construction) on the basis of EUROSTAT 2004 statistics.

Table III.24. : Ratios techniques du fret

Nb of jobs (Gtkm)	Directs	Indirects	Total
Trucks jobs	1 550	562	2 112
rail jobs	534	192	727

Source : DG TREN et estimation Syndex

This estimate of induced jobs for freight transport does not include the whole branch, as ECOTEC does; it allows us however to grasp employment more in terms of its dynamics than of target valuation through the differences between the Base Line and Extended Policy scenarios and a green transport scenario.

3.5. Evaluation of employment changes for the road and rail transport sectors

Reference scenario (BAU)

In the framework of the hypotheses of the base scenario, direct and indirect employment in the public passenger transport sector would be stable in comparison with 2000, whereas employment generated by private passenger transport would increase on average by more than 2% per annum over the period 2000/2010, by close to 1.5% over the period 2010/2020 and by less than 1% over the period 2020/2030. Over the whole period, employment generated by the growth of private passenger transport activity would increase at a rate of 1.6% per annum.

To a lesser extent, employment generated by the growth of rail would also record growth. More sustained over the period 2000/2010 (with an annual average of 1%), it would slow down over the period 2020/2030 (on average 0.55% per annum). Over the whole period the average growth of employment in the rail passenger transport branch would be 0.8%.

In the area of goods transport, employment in the road branch would increase constantly: +2.44% over the period 2000/2010, +2.03% over the period 2010/2020, +1.40% over the period 2020/2030; whereas employment in the rail sector would be almost stable. The average annual growth rate of employment in the road freight branch over the period 2000/2030 would be of the order of 2% while that of employment in the rail branch would only be 0.5%.

Extended Policy scenario

This scenario of rebalancing of private passenger transport in favour of public transport and rail by comparison with the BAU scenario leads to appreciable changes in employment depending on the type of modality.

Table III.25. : passenger and goods transport, base line

passengers transport: Baseline

	1990	1995	2000	2010	2020	2030	1990	2000	2010	2020	2030	Difference		
	Activity (Gpkm)						Jobs					00-10	10-20	20-30
Public road transport	504,1	463,0	480,1	495,0	480,6	466,7	1 984 879	1 890 380	1 949 048	1 892 348	1 837 618	0,31%	-0,29%	-0,29%
Private cars and motorcycles	3 529,3	3 857,5	4 253,1	5 016,6	5 780,7	6 358,6	3 529	7 901 773	9 983 034	11 503 593	12 653 614	2,37%	1,43%	0,96%
Rail	411,9	369,4	402,7	446,4	478,5	505,6	412	1 865 753	2 068 220	2 216 943	2 342 500	1,04%	0,70%	0,55%
Aviation	166,3	212,5	296,9	451,6	616,7	749,7	166							

Freight transport: Baseline

	1990	1995	2000	2010	2020	2030	1990	2000	2010	2020	2030	Difference		
	Activity (Gtkm)						Jobs					00-10	10-20	20-30
Trucks	1 034,1	1 230,4	1 486,3	1 891,2	2 311,7	2 657,4	1 034,1	3 139 233,3	3 994 427,8	4 882 571,3	5 612 728,7	2,44%	2,03%	1,40%
Rail	461,7	358,5	374,2	402,0	421,4	438,9	461,7	272 000,0	292 207,4	306 308,9	319 029,4	0,72%	0,47%	0,41%

The changes in employment in public passenger road transport, unlike the baseline scenario, are in a positive direction with an annual increase of +1.54% over the period 2000/2010, compared with an annual growth of +0.3% for the BAU scenario. Thus, employment in public passenger road transport would be higher by more than 12% in 2010, by more than 24% in 2020 and by more than 33% in 2030, compared with the BAU scenario.

For its part, employment for private passenger transport would show less strong growth than in the BAU scenario, as a result of a less strong growth in activity. Thus, over the period 2000/2010, the increase in employment would be +2.17% as against an increase of +2.37% in the BAU scenario, At the 2010 horizon, jobs generated in the framework of the Extended Policy framework would be 1.87% less in relation to the BAU scenario.

As for employment generated by rail passenger transport activity, it would undergo stronger growth than under the BAU scenario: +2.19% as against +1.04% over the period 2000/2010, i.e. a difference of +12% at the 2010 horizon by comparison with BAU; +1.46% as against 0.70% over the period 2010/2020, i.e. a difference of +20% the 2020 horizon compared with BAU. At the 2030 horizon the difference compared with BAU would be close to 30%.

When it comes to freight, the hypotheses of the Extended Policy scenario would be translated for road freight on one hand as weaker growth over the period 2000/2010: +2.22% rather than +2.44% for the base scenario; on the other hand in the opposite direction over the periods 2010/2020 and 2020/2030, with stronger growth than for the BAU scenario.

Concerning changes in employment for rail freight, it would show an upward movement in stark contrast to the stability of the BAU scenario. To the extent that, at the 2010 horizon, employment generated by rail freight activity would be 15% higher than in the BAU scenario. At the 2030 horizon the difference would be close to 30%.

Table III.26. : passenger and goods transport,
Extended policy scenario

PASSENGER TRANSPORT (IN Gpkm) - Extended policy

						Différence with Baseline					
	1990	2000	2010	2020	2030	2010		2020		2030	
ActivitY (Gpkm)						Montant	%	Montant	%	Montant	%
Public road transport	504,1	480,1	559,2	594,6	623,4	64,2	13,0	114,0	23,7	156,7	33,6
Private cars and motorcycles	3 529,3	4 253,1	4 922,7	5 684,3	6 379,9	-93,9	-1,9	-96,4	-1,7	21,3	0,3
Rail	411,9	402,7	500,2	578,3	650,7	53,8	12,1	99,8	20,9	145,1	28,7

FREIGHT TRANSPORT (in Gtkm) - Extended policy

						Difference with Baseline					
	1990	2000	2010	2020	2030	2010		2020		2030	
Activity (Gtkm)						Montant	%	Montant	%	Montant	%
Trucks	1 034,1	1 486,3	1 851,1	2 378,3	2 975,2	-40,1	-2,1	66,6	2,9	317,8	12,0
Rail	461,7	374,2	462,2	516,5	561,6	60,2	15,0	95,1	22,6	122,7	28,0

Table III.27. : passenger and goods transport,
extended policy lower activity

Passengers transport -extended policy lower activity

	1990	2000	2010	2020	2030	2000	2010	2020	2030	Difference			Difference from baseline		
	Activity (en Md de pkm)					Jobs				00-10	10-20	20-30	2010	2020	2030
Public road transport	504,1	480,1	805,3	1 163,0	1 420,9	1 903 158,8	3 192 419,0	4 610 353,5	5 632 523,4	5,31%	3,74%	2,02%	63,79%	143,63%	206,51%
Private cars and motocycles	3 529,3	4 253,1	4 430,4	4 547,4	4 784,9	7 901 773,3	8 816 555,7	9 280 670,4	9 765 343,0	1,10%	0,51%	0,51%	-11,68%	-19,32%	-22,83%
Rail	411,9	402,7	746,3	1 146,7	1 448,2	1 865 753,4	3 457 852,1	5 312 926,2	6 709 612,0	6,36%	4,39%	2,36%	67,19%	139,65%	186,43%

Freigth transport -extended policy lower activity

	1990	2000	2010	2020	2030	2000	2010	2020	2030	Difference			Difference from baseline		
Activities (Gtkm)										00-10	10-20	20-30	2010	2020	2030
trucks	1 034,1	1 486,3	1 665,7	1 787,4	2 039,2	3 139 233,3	3 518 240,4	3 775 150,3	4 307 024,7	1,15%	0,71%	1,33%	-11,92%	-22,68%	-23,26%
Rail	461,7	374,2	509,4	739,8	892,6	272 000,0	370 276,2	537 756,1	648 802,1	3,13%	3,80%	1,89%	26,72%	75,56%	103,37%

Figure III.16. :Direct employment in road freight transport - Reduction by 10 %
per decade of road transport activity

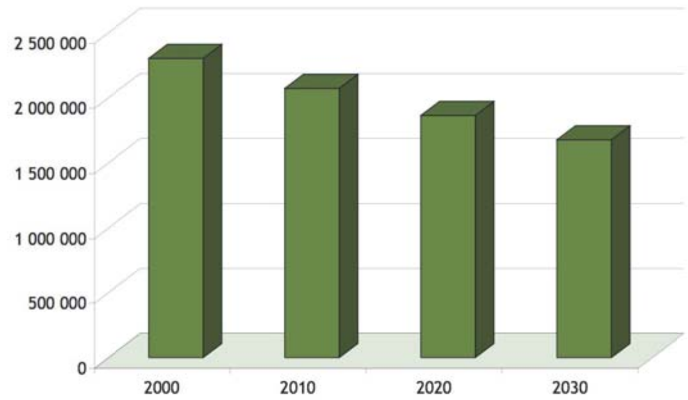
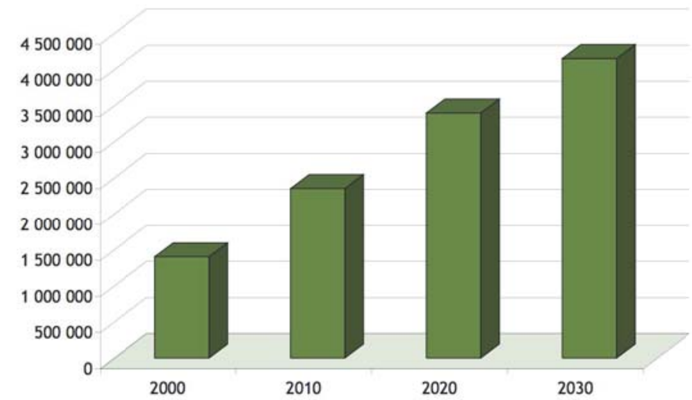


Figure III.17. : Direct employment in passenger road transport – assumption of reduction of private transport activity



“Extended policy-lower freight activity” scenario

Compared with the preceding scenario, this scenario brings stronger employment growth, particularly for passenger public transport modalities (road and rail) as well as for rail freight.

For their part, jobs induced by private passenger transport, although well behind in comparison with the BAU scenario, would grow slightly. Thus, although nearly 12% behind the “Extended Policy” scenario in 2010, private passenger transport activity would generate a 1.1% average annual increase in employment over the period 2000/2010. Over the period 2000/2030, jobs in the private passenger transport branch would increase by an average of 0.71% per year, as against an average increase of 1.59% in the BAU scenario.

Scenario “extended policy – lower freight and passenger actitiy”

Table III.28. : Evolution of employment

	Base line	Extended policy	Lower freight activity	Lower freight activity and passengers
Passengers				
Public road transport	-0,09%	0,87%	3,68%	3,68%
Private cars and motorcycles	1,58%	1,59%	0,71%	0,16%
Rail	0,76%	1,61%	4,36%	4,36%
Total passengers	1,23%	1,49%	2,15%	1,92%
Freight				
Trucks	1,96%	2,34%	1,06%	1,06%
Rail	0,53%	1,36%	2,94%	2,94%
Total freight	1,86%	2,27%	1,25%	1,25%

Overall, policies aiming on the one hand to restrict transport activity and on the other hand to rebalance transport modes in favour of rail in particular for both freight and passenger transport, far from being unfavourable to employment, **these policies would lead to a growth in overall employment** of around 2% on average per year over the period 2000/2030 for passenger transport and 1.25% for freight transport.

On the subject of employment within the **automobile branch**, this would be stable as a result in particular of the increased added value linked to the spread of clean technologies (of course this effect may be more or less strong depending on the rate of coverage of the European market.

In the area of **road freight transport**, the hypotheses we have entertained about reduction in activity (-10% in 2010 compared with the “Extended Policy” scenario, -15% in 2020 and -20% in 2030) affect the intensity of the employment dynamics with a difference of -1 point compared with the BAU scenario and -1.3 points compared with the “Extended Policy” scenario.

To reverse the movement in employment, freight activity would have to be greatly reduced. Thus, on the basis of a hypothesis of a 10% per decade reduction in road freight transport activity over the period 2000/2030, the employment induced would post an average annual reduction of 1.05%.

On the basis of Eurostat statistics, the number of employees directly linked to road freight transport would thus be brought down from 2.3 million in 2000 to 1.6 million in the Europe of 25, i.e. a reduction of 0.7 million employees (on average more than 25,000 employees per year).

Thus, from the point of view of numbers of direct employees, a voluntary policy of reduction of road transport poses concretely the question of the policies of social support for employees, knowing that the rebalancing of passenger transport in favour of public transport offers opportunities for job mobility from freight transport to passenger transport.

In the context of the hypotheses of the “Lower Activity” scenario, rebalancing the lessening of private transport activity partly towards public road transport, would lead to a greater level of employment growth than the losses observed in road freight transport.

Of course, to be sustainable, this scenario requires a partial conversion of motor technologies, depending on distance, to natural gas, hybrid, electric, while waiting for hydrogen, and also an urban and regional planning policy giving priority to clean public transport.

Table III.29. : Transeuropean transport network (TEN-T)

Axes et projet prioritaires			N° liste (1)	Longueur en km	Coût total fin 2004 en M€
Axe ferroviaire	Cork-Dublin-Belfast-Stranraer	Terminé en 2001	L0		
Aéroport de Malpensa		Terminé en 2001	L0		
Liaison fixe de l'Oresund		Terminé en 2000	L0		
Ligne de la Betuwe		En cours	L0	160	4 685
Axe autoroutier	Igoumenitsa/Patras-Athènes-Sofia-Budapest	En cours	L0	2 056	15 543
Axe routier	Royaume-Uni/Irlande/Bénélux	En cours	L0	1 510	4 522
Ligne principale de la côte ouest		En cours	L0	850	10 866
Axe ferroviaire	Berlin-Vérone/Milan-Bologne-Messine-Palerme	En cours	L0 - L1	1 798	45 611
Axe ferroviaire à grande vitesse	Paris-Bruxelles-Cologne-Amsterdam-Londres	En cours	L0 - L1	510	17 457
Axe multimodal	Portugal/Espagne-reste de l'Europe	En cours	L0 - L1	3 332	12 832
Axe ferroviaire/routier triangulaire nordique	Route	En cours	L0 - L1	1 898	10 905
	Rail	En cours	L0 - L1	1 998	
Axe ferroviaire à grande vitesse	Sud-ouest de l'Europe	En cours	L1	2 956	39 730
Axe ferroviaire à grande vitesse	Est	En cours	L1	510	4 373
Axe ferroviaire	Lyon-Trieste-Divaca-Ljubljana-Budapest--frontière ukrainienne	En cours	L1	1 482	37 655
Galiléo		En cours	L1		3 400
Axe ferroviaire	Paris-Strasbourg-Stutgart-Vienne-Bratislava	En cours	L1	882	10 077
Axe fluvial	Rhin / Meuse-Main-Danube	En cours	L1	1 542	1 889
Interopérabilité des lignes à grande vitesse dans la péninsule ibérique		En cours	L1	4 687	22 313
Axe ferroviaire	Détroit de Fehmarn	En cours	L1	448	7 051
Autoroutes de la mer		En cours	L1		
Axe ferroviaire	Athènes-Sofia-Budapest-Vienne -Prague-Nuremberg/Dresde	En cours	L1	2 100	11 125
Axe ferroviaire	Gdansk-Varsovie-Brno/Bratislava-Vienne	En cours	L1	1 291	5 488
Axe ferroviaire	Lyon/Gênes-Bâle-Duisburg-Rotterdam/Anvers	En cours	L1	1 241	22 724
Axe autoroutier	Gdansk-Brno/Bratislava-Vienne	En cours	L1	1 039	7 777
Axe ferroviaire/routier triangulaire nordique	Irlande/Royaume Uni/Europe Continentale	En cours	L1	1 035	4 714
"Rail Baltica"	Axe Varsovie-Kaunas-Riga-Tallinn-Helsinki	En cours	L2	1 190	2 650
Canal fluvial Seine-Escaut		En cours	L2	185	2 494
Axe ferroviaire	Corridor intermodal mer Ionienne/mer Adriatique	En cours	L3	792	2 489
Axe ferroviaire de fret	Sines/Algeciras-Madrid-Paris	En cours		526	6 060
"Eurocaprail" sur l'axe ferroviaire Bruxelles-Luxembourg-Strasbourg		En cours		194	1 409
	TOTAL			36 212	315 839

3.6. *Trans-European Transport Network (TEN-T)*

Community guidelines

In July 1996, the European Parliament and the Council adopted Decision No. 1692/96/EC on community guidelines for the development of the Trans-European Transport Network (TEN-T). These guidelines, which concern roads, railways, navigable waterways, airports, seaports, inland navigation ports and traffic management systems, provide for implementation of the network by 2010.

Unfortunately, work is not progressing as rapidly as had been anticipated.

In 2001, the Commission initiated an initial revision of the TEN-T orientations following the guidelines of the White Paper on European transport policy for 2010. This modification aims to remove the bottlenecks in the existing or proposed network without adding new routes, concentrating investments on a small number of horizontal priorities and on a number of new projects.

In 2003, a new, more fundamental, revision of the TEN-T orientations was proposed by the Commission in order to take account of enlargement and the expected changes in traffic flow. The report presented lists the priority infrastructure projects and provides a set of recommendations which are supposed to allow the necessary finances to be found for their realisation and to coordinate the investments within the TEN-T.

Concerning the priority projects, the "High-Level Group on TEN-T" (set up by the Commission) recommends to the latter that it concentrate on two major objectives:

- **Completing 5 of the Essen projects before 2010.**

  Some projects are completed or being completed with commissioning envisaged before 2007. These projects are listed in list 0 (L0 in the table opposite).

- **Starting 22 new priority projects in the enlarged Union for 2020.**

  Taking account of the commitments made by the Member States concerned, 18 of these projects could be operational by 2020. They figure in list 1 (L1 in the table opposite).

  4 less completed projects also present a strong European added value (viz the extent to which they facilitate trade between Member States). However, the group was not able to get all the countries involved to commit to starting implementation before 2010. These projects are given in list 2 (L2 in the table opposite).

Table III.30.: List 2

1.	New high-capacity trans-Pyrenean rail link
2.	Rail Baltica: Helsinki-Tallinn-Riga-Kaunas-Warsaw
3.	Rail link Gdansk-Bydgoszcz-Zwardon reserved for freight
4.	River link Seine-Scheldt

Table III.31.: List 3

1- Network accessibility and interconnection
Multimodal logistics centre at Slawkow (Poland) with connections to rail network with Russian gauge
Rail line Bari-Durres-Sofia-Varna/Bourgas (Black Sea)
Rail line Naples-Reggio Calabria-Palermo
Road/rail corridor linking the West and Dublin
Port of Limassol and road access to this
Port of Larnaka and road access to this
Ports of La Valette and of Marsaxlokk
Intermodal corridor Ionian Sea/Adriatic
Road Dover-Fishguard
2- Cross-border links
Motorways Dresden/Nuremburg-Prague-Linz
Railway Prague/Linz
Motorway Zilina-Bratislava-(Vienna)
Railway Maribor-Graz
Motorway (Ljubljana)-Maribor-Prince-Zamardi-(Budapest)
Improvement of road crossing of Pyrenees

Table III.32. : Transeuropean transport network (TEN-T) - EIB study

			BEI				
			Emploi temporaire		Emploi permanent	TOTAL	
Axes et projet prioritaires			Minima	Maxima		Minima	Maxima
19	Axe ferroviaire	Cork-Dublin-Belfast-Stranraer					
10	Aéroport de Malpensa						
11	Liaison fixe de l'Oresund						
5	Ligne de la Betuwe		640	27 200		640	27 200
7	Axe autoroutier	Igoumenitsa/Patras-Athènes-Sofia-Budapest	16 448	174 760	310 860	327 308	485 620
13	Axe routier	Royaume-Uni/Irlande/Bénélux	12 080	128 350	90 440	102 520	218 790
14	Ligne principale de la côte ouest	Rail	3 400	144 500		3 400	144 500
1	Axe ferroviaire	Berlin-Vérone/Milan-Bologne-Messine-Palerme	7 193	305 711		7 193	305 711
2	Axe ferroviaire à grande vitesse	Paris-Bruxelles-Cologne-Amsterdam-Londres	2 040	86 700		2 040	86 700
8	Axe multimodal	Portugal/Espagne-reste de l'Europe	22 388	373 915		22 388	373 915
12	Axe ferroviaire/routier triangulaire nordi	Route	15 184	161 330	218 100	233 284	379 430
		Rail	7 992	339 660		7 992	339 660
3	Axe ferroviaire à grande vitesse	Sud-ouest de l'Europe	11 824	502 520		11 824	502 520
4	Axe ferroviaire à grande vitesse	Est	2 040	86 700		2 040	86 700
6	Axe ferroviaire	Lyon-Trieste-Divaca-Ljubljana-Budapest--frontière ukrainienne	5 928	251 940		5 928	251 940
15	Galiléo						
17	Axe ferroviaire	Paris-Strasbourg-Stutgart-Vienne-Bratislava	3 528	149 940		3 528	149 940
18	Axe fluvial	Rhin / Meuse-Main-Danube					
19	Interopérabilité des lignes à grande vitesse dans la péninsule ibérique		18 748	796 790		18 748	796 790
20	Axe ferroviaire	Détroit de Fehmarn	1 792	76 160		1 792	76 160
21	Autoroutes de la mer						
22	Axe ferroviaire	Athènes-Sofia-Budapest-Vienne -Prague-Nuremberg/Dresde	8 400	357 000		8 400	357 000
23	Axe ferroviaire	Gdansk-Varsovie-Brno/Bratislava-Vienne	5 164	219 470		5 164	219 470
24	Axe ferroviaire	Lyon/Gênes-Bâle-Duisburg-Rotterdam/Anvers	4 964	210 970		4 964	210 970
25	Axe autoroutier	Gdansk-Brno/Bratislava-Vienne	8 308	88 273	155 540	163 848	243 813
26	Axe ferroviaire/routier triangulaire nordi	Irlande/Royaume Uni/Europe Continentale	4 140	175 950		4 140	175 950
27	"Rail Baltica"	Axe Varsovie-Kaunas-Riga-Tallinn-Helsinki	4 760	202 300		4 760	202 300
30	Canal fluvial Seine-Escaut						
29	Axe ferroviaire	Corridor intermodal mer Ionienne/mer Adriatique	3 168	134 640		3 168	134 640
16	Axe ferroviaire de fret	Sines/Algeciras-Madrid-Paris	2 104			2 104	
28	"Eurocaprail" sur l'axe ferroviaire Bruxelles-Luxembourg-Strasbourg		776	32 980		776	32 980
		TOTAL	173 009	5 027 759	774 940	947 949	5 802 699

The group also studied a series of projects contributing to economic and social cohesion. The ability of many regions to catch up economically, particularly in the future Member States, will depend on accessibility great trans-European axes and on the efficiency of interconnections with other networks, in particular by high-performance cross-border connections. These projects are given in list 3 (see table III.31).

Effects on employment of these various infrastructure projects

We based our work on two studies, listed below, which were carried out by the European Investment bank (EIB), in the case of the first, and by the (French government agency) Conseil Général des Ponts et Chaussées (CGPC) for the second.

Even though the calculations are made on a different basis (for the EIB, it takes account of the kilometres to be laid – for the CGPC, it takes account of the cost of the infrastructure), the results lead to the potential creation of 5.8 million jobs.

EIB: Contribution of Major Road and Rail Infrastructure Projects to Regional Development (August 1998)

This study, which covers a sample of 23 road and rail operations, shows that, in general, the impact on employment of investments in transport infrastructure is important in its totality but small per unit of realisation and commissioning of this infrastructure.

In the road as much as the rail sector, temporary employment per kilometre laid varies greatly from one operation to another:

- Employment per kilometre of road is between 8 and 85 man-years (m-y) and may double or even triple for operations in the same country.
- Employment per kilometre of railway lies between 4 and 170 m-y.

Permanent jobs are mainly destined for tollbooths, station operations, maintenance of the works or security.

The study showed that the employment created by tollways slightly exceeds 100 positions for an average cost per position of 5 million ecus expressed in 1996 values. It remains marginal or non-existent for railway operations. The study emphasises, on this subject, that these are new positions which, because of the very high level of surplus staff in the majority of European railway companies, have been filled by internal transfer without generating new hirings.

The conclusions of this study corroborate another EIB study which concludes that, overall, transport infrastructure creates few direct permanent jobs, and that the number created is variable from one operation to another.

On the basis given above, if the decision were taken to undertake all the infrastructural works, one would achieve the creation of a number of jobs in the range from 1 to 5.8 million (see table opposite).

This simulation seems to be corroborated, below, by the study by the Conseil Général des Ponts et Chaussées (CGPC).

CGPC: Effects on employment of the construction, maintenance and operation of major road infrastructure

Roadworks put in place a whole series of jobs, of which it is hard to say whether to call them jobs created, jobs displaced, long-term jobs, or short-term jobs.

The effects on employment can be broken down as follows, for a roadworks project of 1,000 MF 1995, or ¾78.11M 2005:

- Direct jobs linked to roadworks: 1,100 job-years[48]
- Direct jobs at head office: 110 job-years
- Indirect jobs

[48] job-years = number of jobs multiplied by the total duration of the works

Table III.33. : Transeuropean transport network (TEN-T) - study CPCG

	Axes et projet prioritaires		Emplois directs	Emplois indirects	Effet revenu	Total
19	Axe ferroviaire	Cork-Dublin-Belfast-Stranraer				
10	Aéroport de Malpensa					
11	Liaison fixe de l'Oresund					
5	Ligne de la Betuwe		32 405	32 940	21 424	86 769
7	Axe autoroutier	Igoumenitsa/Patras-Athènes-Sofia-Budapest	107 506	109 283	71 078	287 866
13	Axe routier	Royaume-Uni/Irlande/Bénélux	31 277	31 794	20 679	83 750
14	Ligne principale de la côte ouest		75 156	76 399	49 690	201 245
1	Axe ferroviaire	Berlin-Vérone/Milan-Bologne-Messine-Palerme	315 478	320 692	208 580	844 750
2	Axe ferroviaire à grande vitesse	Paris-Bruxelles-Cologne-Amsterdam-Londres	120 744	122 740	79 831	323 315
8	Axe multimodal	Portugal/Espagne-reste de l'Europe	88 755	90 222	58 681	237 657
12	Axe ferroviaire/routier triangulaire nordique	Route Rail	75 426	76 673	49 869	201 968
3	Axe ferroviaire à grande vitesse	Sud-ouest de l'Europe	274 799	279 341	181 685	735 825
4	Axe ferroviaire à grande vitesse	Est	30 247	30 746	19 998	80 991
6	Axe ferroviaire	Lyon-Trieste-Divaca-Ljubljana-Budapest--frontière ukrainienne	260 447	264 752	172 196	697 395
15	Galiléo					
17	Axe ferroviaire	Paris-Strasbourg-Stutgart-Vienne-Bratislava	69 699	70 851	46 082	186 632
18	Axe fluvial	Rhin / Meuse-Main-Danube	13 066	13 282	8 638	34 985
19	Interopérabilité des lignes à grande vitesse dans la péninsule ibérique		154 331	156 882	102 037	413 251
20	Axe ferroviaire	Détroit de Fehmarn	48 769	49 575	32 244	130 589
21	Autoroutes de la mer					
22	Axe ferroviaire	Athènes-Sofia-Budapest-Vienne -Prague-Nuremberg/Dresde	76 948	78 220	50 875	206 042
23	Axe ferroviaire	Gdansk-Varsovie-Brno/Bratislava-Vienne	37 959	38 586	25 097	101 641
24	Axe ferroviaire	Lyon/Gênes-Bâle-Duisburg-Rotterdam/Anvers	157 174	159 772	103 917	420 863
25	Axe autoroutier	Gdansk-Brno/Bratislava-Vienne	53 791	54 680	35 564	144 035
26	Axe ferroviaire/routier triangulaire nordique	Irlande/Royaume Uni/Europe Continentale	32 605	33 144	21 557	87 306
27	"Rail Baltica"	Axe Varsovie-Kaunas-Riga-Tallinn-Helsinki	18 329	18 632	12 118	49 080
30	Canal fluvial Seine-Escaut		17 250	17 535	11 405	46 190
29	Axe ferroviaire	Corridor intermodal mer Ionienne/mer Adriatique	17 216	17 500	11 382	46 098
16	Axe ferroviaire de fret	Sines/Algeciras-Madrid-Paris	41 915	42 608	27 712	112 235
28	"Eurocaprail" sur l'axe ferroviaire Bruxelles-Luxembourg-Strasbourg		9 746	9 907	6 443	26 096
		TOTAL	2 161 036	2 196 755	1 428 784	5 786 574

- Jobs linked to the manufacturing of roadworks supplies: 660 jobs
- Jobs linked to employment effects of activities upstream of roadworks: 570 jobs
- Jobs linked to income distributed. These are the effects linked to the additional expenditure corresponding to the wages paid during the roadworks and to the wages paid by activities upstream of roadworks. Any additional income automatically creates new consumption depending on the marginal consumption and importation function, and therefore additional production which produces new income. The jobs corresponding to this effect are estimated at 800 job-years.

To sum up, the direct and indirect jobs estimated over the whole duration of the works amount to 3,240 jobs for ¾74.94M of 2004 after tax (1,000MF of 1995).

In total, the potential creation would amount to 5.8 million jobs for the totality of these infrastructural works.

3.7. Recommendations for transport policy

The scenarios described above show that, overall, policies aiming on the one hand to restrict transport activity and on the other hand to rebalance transport modes in favour of rail in particular for both freight and passenger transport, far from being unfavourable to employment, these policies would lead to a growth in overall employment.

For these positive effects to materialise, policies must be integrated, combining regulatory, economic and market based instruments, research and development, demand restraint, the provision of alternatives, improvement of social conditions in the road transport sector, investment in training and social dialogue.

Implement a wide range of economic, regulatory and market based instruments

Regulation is one of the key instruments to promote the objective of modal shift and more efficient transport modes, through the development of public transport and inermodality road-rail (interoperability of railway networks and technical harmonisation, regulation of road transport) as well as emissions standard for vehicules. For example, the ban on heavy vehicles travelling at night in Switzerland an effect on the division of freight across modes.

Major efforts are required to develop trans-european transport networks contributing to reduce emissions from transport (multimodal platforms, railways, multimodal corridors, river links) as well as those necessary for new fuels such as hydrogen.

Given the expected increase in trafic, the rapid spread of clean motor technologies, namely natural gas, hybrid, electric, while waiting for hydrogen, is a strategic issue and supposes appropriate measures in financing of research and development.

It is to be hoped that the European Union adopts a general harmonised fiscal policy for all transport networks – roads, motorways, railways- aiming at internalising external social costs of various transport modes, while improving social conditions in the road transport sector.

Finally, regional planning policies that have led to a major expansion of urban zones without regard to the consequences in the area of travel and energy efficiency will have to be corrected: policy of localisation of activities, control of urbanisation and planning of urban roadways, evaluation of planning policy.

Issues for job quality

The scenarios described above also involve qualitative changes in transport-sector employment.

The improvement of social conditions in the road transport sector will constitute an essential factor to change the distribution across modes within the framework of a policy of transport emissions control. The competitiveness of rail, and *a fortiori* of intermodal transport, in comparison with road, will be strengthened by the effective application of working-hours and rest-time legislation in road transport. Moreover, the liberalisation of the road transport market in the framework of the enlargement of the EU will put pressure on road transport prices if it is not accompanied by harmonisation in the social area and of road safety among Member States of the EU.

Further, with the development of combined unaccompanied transport – which represents the majority of combined road-rail transport – we would move from a system requiring drivers for long distances to a system where the drivers, used for feeder transport, are able to go home every evening, which would constitute a benefit for welfare and safety and could encourage the employment of women as drivers.

The alternative of accompanied combined road-rail transport, although more job-intensive, carries social risks: to the extent that time spent in the train is regarded legally as rest time for the drive, i.e. unpaid, there is a risk of downgrading working conditions.

The rail sector is still under restructuring, which could involve at times negative consequences for both existing staff and for the attractiveness of the sector. It seems for example that a dangerous shortage of skilled personnel is emerging: historical enterprises have reduced the number of apprenticeships in an effort to reduce costs, while the necessary skills are not provided by vocational training.

Social dialogue as a facilitator of change

Transfer between modes, at a port or interchange point, and in transport generally, requires organisational changes to reach international standards of efficiency. Social negotiation at the state level has an important role to play in helping to grasp opportunities which cannot be grasped in the framework of today's strict rules.

As emphasised by A. Gille, president of the French national transport council, there will hardly be any effective organisational progress without a joining together or at least understanding between those who produce it[49]. Social dialogue can be a tool for collective understanding at the highest levels of decision-making.

In a voluntarist scenario of reduction of road transport, social dialogue may also contribute to the design of social policies aiming at supporting job mobility from road transport towards public transport or other activities.

Investing in training

Taking account of the appearances of shortages of skilled personnel in the railway sector, it will be necessary, at the European level, to develop training networks for jobs in the railway sector in order to create a true job market for railway and infrastructure-management companies. In this way, productivity will be able to be reinforced by a modernisation of labour organisation and by investment in training, taking account of the quality of employment, a key element of the Lisbon strategy[50].

[49] A. Gille (2006), « La comodalité, outil du développement durable », Revue Transports, March-April
[50] Report on the implementation of the first railway package, COM(2006) 189 final

4. The iron and steel sector

4.1. Employment in European iron and steel: trends and breakthroughs

The last 20 years of European iron and steel—the big picture

Over the last thirty years, the period between the years 1975 and 2005, the West-European iron and steel industry has been marked by:

- the management of production capacities in the framework of the institutional mechanisms organised by the CECA treaty, then its ending in 2001 allowing European iron and steel producers to join the competitive economy without regulation other than commercial regulation
- the modernisation of its production tools which has seen in particular the generalisation of continuous pour and the advancement of electric steelworks which are the principal source in Europe of steel for the majority of long products for the building sector
- the maintenance of the pig-iron route for flat products in particular for the automotive sector
- the privatisation of the majority of steel producers which was preceded and accompanied by a concentration of producers, initially on the national scale, then at the European scale
- a drastic reduction in the numbers employed due to a reduction in production capacities as well as the continuing realisation of labour productivity gains
- a strategy on the part of the main European producers more and more oriented towards high-added-value steel products
- at the last, some increase in European steel production, accompanied, however, by a reduction of steel exports to third countries

In Eastern Europe, the iron and steel industries experienced a discontinuity starting from the transitional period of the 1990s which was manifested by:

- a deep production crisis arising notably from a strong reduction in internal consumption
- partial modernisation of production tools under state sponsorship followed by privatisation involving the internationalisation of the capital of the surviving iron and steel companies
- a drastic reduction in the number of production units and of the numbers employed in the sector, which in some countries is still going on as part of the process of joining the European Union (Poland)
- a concentration of the sector after the Mittal Steel group took control of the principal Romanian, Czech and Polish steel producers

In sum, the European iron and steel industries, both Eastern and Western, have entered into a process of progressive integration since the accession of the new Member States, effective from 1 May 2004 and 1 January 2007.

This integration accelerated sharply in 2006 with the creation of the Arcelor Mittal group, bringing the industries of the East and the West of Europe together under the same banner on a significant scale for the first time in the history of European iron and steel.

The principal European iron and steel producers brought together in the new group form part of the first global steel group, which represents on its own around 10% of global raw steel production.

The branch conversions of the 90s

The latest technical mutation of the iron and steel sector was marked by the extension of electric steelworks either by the creation of new units or by the conversion of former converters into sites equipped with electric furnaces. The most spectacular part of this transformation was the total conversion of the Luxembourg iron and steel industry at the beginning of the 90s.

Workforce reductions resulted from this at the time, fed by the change in size of the units but also by decisions to outsource numerous services made in parallel. After this wave, which lasted until 1998-2000, the conversion movement stopped, and we can say that under current economic circumstances the sites producing steel from pig iron are doing better than the electrified sites. This phenomenon is particularly visible for those products where the two production branches are still in competition on European markets, such as machine wire.

This branch conversion which affected the major part of the steel long products industry in Europe undoubtedly made a major contribution to the drop in CO_2 intensity per tonne of steel in the period (-22% in the OECD countries between 1990 and 2003, *source: John Newman OECD Committee Paris 11/2006*). The current cessation of this conversion movement requires the opening of new paths towards lowered emissions.

The New Deal for iron and steel from 2003

The new economic situation for the iron and steel industry since 2003 presents three structural characteristics:

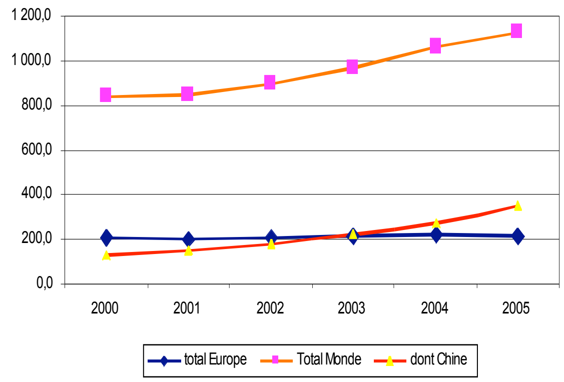
- the globalisation of the sector and of steel producers
- Chinese economic growth, which has a strong iron and steel component in its current phase
- the increase of raw-material prices

Thus the European integration described above is taking place in a context of increasing globalisation of the sector. If Arcelor and Mittal combined constitute the biggest European group, the production units of the new group are geographically dispersed over the whole of the steel-making world: North and South America, Kazakhstan, South Africa, China..., and soon India.

To this first disruptive factor is added that of the new presence of China as the principal steel-producing country and the only production growth factor at the global scale for the last few years.

In fact, while European and American steel production advanced at a slow and uncertain pace, China burst onto the scene in the course of the year 2004 and made a lasting transformation to the economy of the sector by bidding up the prices of raw materials.

Fig. III.18.: compared evolution of gross steel productions



This resulted in historical price rises for smelting feedstock over a very short period, which led to producers of steel by the pig-iron route and especially the electric route to urgently revise their sales prices upwards from the beginning of 2004.

In fact, beyond the fallout from the increase in raw materials prices, the great majority of iron and steel companies took advantage of the situation to increase their margins and their profits.

The period beginning in 2004 will thus have seen China transform the world economy of the sector and allow the economic and financial recovery of numerous groups and companies in both Europe and the United States.

But at the same time the new-found importance of access to raw materials at competitive prices momentarily threw into disarray the strategies pursued by European producers oriented towards the added value of their products. This resulted in a new fragility for European producers, which has recently been seen in hostile and friendly takeovers: Arcelor by Mittal Steel, Corus by the Indian producer Tata Steel or the Brazilian CSN...awaiting Chinese investors. Thus groups producing high-added-value steels have been acquired by producers focussed on the production of common or "commodity" steels.

In this way are born iron and steel groups combining geographical diversification with a great diversity of products and of processes using a wide variety of raw materials: iron ores, concentrates and pellets upstream and pig-iron, scrap iron and pre-reduced products downstream.

Europe, whose supremacy in the field of iron and steel had never been contested by the USA, has been well and truly overtaken by China since 2003. It risks tomorrow being marginalised by the production of emerging countries over the next few years.

Employment in European iron and steel

Employment in the European iron and steel industry over the last twenty years has been marked by continued reduction in workforce numbers, and this despite a continuing, even slightly increasing, high level of production.

Over the latest period of 10 years, Western European iron and steel will have shed around 80,000 jobs, going from 330,000 to 250,000 for a production which has stabilised at 160 MT. The apparent physical productivity gains measured by the number of tonnes of raw steel per employee have thus been 28% in around 10 years.

How will it be tomorrow for a sector which employs around 350,000 in 2005 in the 25 countries of the European Union, split roughly into 250,000 in the West and 100,000 in the East?

Table III.34.: Number of salaries in the European steel industries

	2004
Autriche	11000
Belgique	18000
Danemark	1000
Finlande	7600
France	34000
Allemagne	72500
Grèce	2100
Italie	39000
Luxembourg	4100
Pays Bas	10500
Portugal	600
Espagne	21600
Suède	12500
Royaume Uni	19600
Republique Tchèque	24787
Hongrie	6561
Pologne	27830
Lettonie	7062
Slovénie	2715
Bulgarie	9830
Roumanie	39963
total	**372848**

source: Eurofer et Eurostat

We shall deal with this subject on the basis of two factors which determine the employment level in an industrial sector today.

- The competitiveness of the sector which determines its production level and the value added
- The social and industrial policy pursued in the sector by European, national and local public authorities, with particular emphasis on one hand on research and development efforts and on the other hand the renewal of employee populations in a sector marked by the aging of its workforce.

Fig. III.19. : Cost structure of the pig-iron route

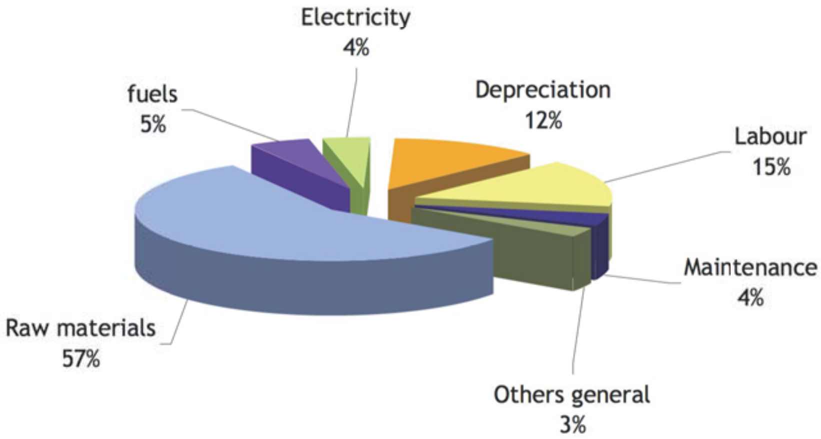
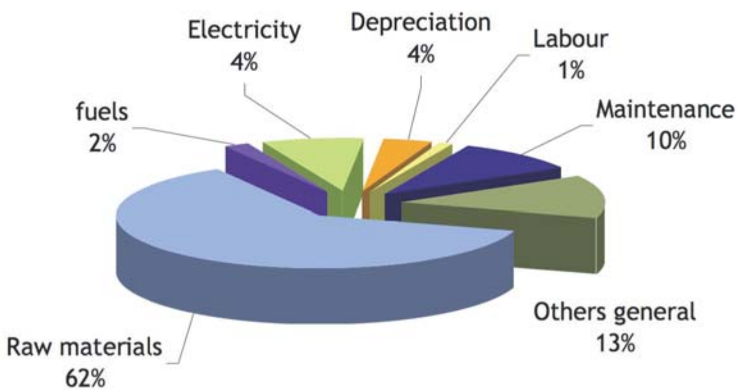


Fig. III.20. : Cost structure of electric route



4.2. Two routes: pig-iron and electric, with different economies and different environmental consequences

According to available data, the steel sector is responsible for 5% of greenhouse gas emissions at the global level; the proportion for Europe is as high as 6%. But these figures should be treated with caution because of questions of scope of steel-making installations.

The peculiarity of the sector resides in the close relationship between its production process and that of the production of CO_2:

- by the pig-iron route (60% of European steel production), each tonne of steel produced generates around 2 tonnes of CO_2;
- by the electric route (40% of European steel production), direct emissions amount to only 150 kg of CO_2 per tonne of steel.

Thus it would suffice to produce steels by melting scrap in an electric furnace to solve a large part of the problem. This vision is in evidence in some publications. This approach is founded on the clean nature of electric steelmaking in Europe, which emits only 5% of the CO_2 arising from steel production.

But to do this would require the substitution of more than 60% of European steel production, either by new electric steels or by imports.

In Europe, only an increase in imports, leading to a large trade deficit, is possible, because the production of electric steel cannot be extended because of the increasing unavailability of scrap, a phenomenon which has recently produced a price inversion compared with pig-iron: for some months, pig-iron has had a distinctly lower cost of production than the purchase price of scrap in Europe.

The condition *sine qua non* of an extension of electric steel production in Europe, the availability of scrap, is thus not fulfilled.

The alternative of using direct-reduction iron (DRI) as a feedstock is very limited at the economic level by the use of natural gas replacing coal as a reducing agent. In fact, neither the availability nor the price of natural gas in Europe are favourable to this development.

Other procedures are currently being studied but cannot constitute an alternative in the short term.

The second reason which makes the extension of the electric route improbable in the medium and long term relates to the cost of electricity, which, in the comparison between the two production techniques, favours the pig-iron route. Unlike the electric route, which consumes electricity, pig-iron production traditionally generates electricity and therefore income through the commercialisation of coking and blast-furnace gases.

Taking account of these factors, the study carried out by Syndex for the European Metalworkers' Federation in 2004 concluded:

"The impact of the application of the Kyoto protocol on the European iron and steel industry will depend fundamentally on new medium-term price balances between on the one hand the indispensable raw materials for producing new iron: iron ore, coal and coke, and on the other hand the raw materials needed to produce recycled iron: scrap and electricity"

It must be observed that developments have been favourable to the pig-iron route and that the phenomenon seems set to last.

The comparison of the cost structures of the two branches published by the IEA gives an initial impression of the impact of the relative prices of raw materials in the two branches of production for 2004:

This shows us the greater sensitivity of electric steel to the cost of raw materials, as sources of both iron and energy: together they represent 72% of the total as against 66% for the pig-iron route, this latter figure needing to be reduced by the exploitation of blast-furnace gases.

Between 2004 and 2006 in Europe, relative price movements in the raw materials feeding the two branches of steel production have been favourable to the pig-iron route, the one which emits much more CO_2 per tonne of steel.

Doing nothing would probably lead in the short term to a replacement of electric steel by pig-iron steel, in other words of "clean" steel by less clean steel.

To resolve this question, it would be desirable to neutralise the carbon impact on the comparative competitiveness of the two branches of steel production and for this purpose to determine a level of constraint differentiated according to the origin of the steel.

4.3. The effects of setting a carbon price

The emission rights market

Reminders

Every unit producing CO_2 is allocated a certain number of emission rights by the state, essentially free of charge (a quota), which forms part of a National Allocation Plan (NAP), over a given period. To date, two periods have been set: 2005-2007 and 2008-2012.

Quotas are allocated for each site on the basis of past emissions and emissions predicted for the period to come. For the iron and steel industry there is a relative proportionality between the level of production and that of emissions.

Thus the granting of a future level of emissions can be assimilated to an industry policy measure in that it may favour or on the contrary handicap a site through the impact of the allocation on the cost price of its production.

This grant of a quota is determined per period and is cancelled from the moment production stops on the site in question, that is, the state and not the company remains owner of the quotas.

Since the beginning of 2005, CO_2 emission rights have been listed on a futures market. This has resulted in a variable price level (¾10 to ¾30 per tonne).

Initial lessons

How do things stand today, two years after the greenhouse gas emission quotas began to be applied to the European iron and steel industry?

On the application of the Emissions Trading Directive during the period 2005-2008 in the various states of the European Union and the treatment given to the iron and steel industry, it appears that:

- the implementation of CO_2 measures has been the subject of different definitions of the production tools taken into account in the countries in the Union, introducing risks of real distortions between units[51].
- the allocation of free emission rights turned out to be excessive for 2005 with a "favourable" factor which was the low growth of steel production in Europe or even in some countries a reduction
- all up, a high level of opacity on the allocation of emission rights, in particular if measurement is made per tonne of steel produced rather than by production site.

The incentive to reduce CO_2 emissions from carbon restrictions on the sector seems in the end to be rather weak.

[51] Approximately 80% of production by the pig-iron route and by the electric route has a definition excluding certain tools, while the remaining 20% has a broad definition of the tools concerned.

The year 2005

For the first year of application, the iron and steel industry was allocated 197 MT of CO_2, compared with 158.7 MT of certified emissions for the year. In total the surplus allocation will have reached 24% of the total allocated.Several reasons are behind this:

- the reduction in European steel production, which fell by 3.5% between 2004 and 2005; the quantitative effect is estimated at 5.9 MT of CO_2 (source: Cheuvreux, 2006)
- the attribution of quota to installations undergoing expansion of capacity which have not been put into production
- a technical quota allocation issue linked to blast-furnace gas attributed to the iron producer in some countries and in others to the downstream electricity generator.
- over-allocation for fear of a negative effect on the competitiveness of the European iron and steel industry

The European iron and steel industry has thus had a total windfall benefit estimated at ¾478 million at the price of ¾12.5 per tonne of CO_2. This amount represents 0.7% of the turnover of the sector according to the calculations presented in the table below. The distribution of this benefit is unequal between the pig-iron route (1% of turnover) and the electric route (0.1% of turnover).

Some enterprises have already sold excess emissions rights from 2005 while others have been more prudent, saving their rights for the two remaining years 2006 and 2007.

It remains the case that, on the whole, the industry has realised a tidy windfall profit which, compared with the research effort committed to technologies allowing a reduction of CO_2 emissions (45 billion euros a year over the first phase of the Ulcos 2005-2012 programme), appears very major.

Table III.35. : estimation of carbon impact on European steel sector

	Filière Hauts fourneaux	**Filière électrique**	**total**
Données activité 2005			
production (Mt)	114,2	73	187,2
Prix € / tonne	380	380	380
activité M€ (CA)	43 404	27 750	71 153,9
Profil carbone			
TCO_2 par tonne produite	1,93	0,15	1,24
Émissions de CO_2 (Mt)	220,4	11	231,4
Excès de quotas (Mt)	35,4	2,8	38,2
Bénéfice exceptionnel	443,1	34,4	478
Impact en % de l'activité	**1,0 %**	**0,1 %**	**0,7 %**
Électricité			
MWh / T	0,37	0,65	0,48
Consommation totale (TW)	43	47	90
Autosuffisance du secteur (%)	40 %	10 %	24 %
Coût supplémentaire d'électricité (M€)	161	269	431
Coût supplémentaire / tonne	1,4	3,7	2,3
Impact en % de l'activité	**-0,40 %**	**-1 %**	**-0,61 %**
Impact carbone total en % de l'activité	**0,65 %**	**0,85**	**0,07 %**

source: IEA, Eurofer, Chevreux

Tradable CO_2 emission rights should not be analysed as a tax but rather as the price of a new by-product

The various studies that have tried to determine the impact of carbon restrictions on the industries in question and in particular iron and steel have assimilated the effect of emission rights to a carbon tax.

This route does not seem appropriate, because the system of free emission rights allocation up to a certain level to industrial producers may either

- Give the production unit an insufficient quota in the case of a higher-than-predicted production and in this case the additional cost corresponding to the marginal tonnage is proportional to the excess carbon emitted, or
- on the other hand allocate excess quotas in the case of a drop in production and in this case possibly obtain additional revenue for the unit, also in proportion to the relevant tonnage not produced.

Moreover the price is neither fixed nor known in advance, which adds an opportunity effect.

This opportunity effect is increased by the way the market price on the CO_2 exchange varies according to criteria that are largely external to the iron and steel sector.

Thus, if a tax corresponds to an additional cost, everything works out as though the CO_2 emitted were a by-product of production, which the unit exploits commercially or not depending on a number of parameters such as:

- the allocation of rights to the unit in relation to its production capacity (and therefore on the working hours of its employees)
- the technical flexibility of the combustion installations (and of the rate of work of the employees)
- the economic, social and financial opportuneness of producing steel at a given time

Thus the introduction of the carbon market logically introduces new technical, economic and social criteria into the management of steel production units.

We shall conclude on this point that CO_2 is a by-product with a market price affecting the financial equilibrium of production and as such subject to arbitrage with the totality of production factors.

The iron and steel sector will be all the more sensitive to this price if the quotas attributed to it in future demand major emission reductions and if the price per tonne of carbon is raised.

The price of carbon negotiated on the emissions rights exchange is in no way dependant on the negotiation of these rights coming from steel producers. For the sector it is an exogenous quantity.

It is then probable if not certain that the price of carbon will be an integral part of the flexibility factors of a steel production unit and that the level of production will be affected on this basis.

This could then result, for more and more employees and sub-contractors, a correlation between the price of CO_2, the profit margin on the products produced and the number of hours of production.

Instead of targeting the level of pollution as a differentiating criterion, it is rather the level of production which is decisive in the current system.

The paradox of the localisation of emissions rights in a globalised iron and steel industry

As a result the allocation of emission rights is geographically localised, management by production site has run up against the ongoing process of globalisation.

Whereas one observes an increasing fluidity of production allocations and increasing exchanges of raw materials and semi-finished products between units of the same trans-national group established in several countries, the allocation of emission rights continues to be determined by states and attached to each site of liquid steel production.

This results in competitive advantages for producers with surplus rights and for producers not subjected to any restriction. In the other direction, those that emit the least CO_2, who ought to be the first to benefit, do not necessarily derive any advantage from it.

This paradox expresses itself in Europe and more particularly in the iron and steel industry in several ways:

- in the first place, iron and steel producers claim to be unable to reflect the price of CO_2 in their sales prices given their increasingly global prices and the risk of the European iron and steel industry's losing competitiveness against iron and steel industries of countries having no carbon restriction expressed in costs
- secondly, European steel producers underscore the difference in their treatment with that of electricity generators who on the contrary have been able to reflect the additional cost of carbon in their sales prices even if it is not at all proven that they have had to bear it, and this is possible only because a comparable competitive situation doesn't exist on European electricity markets.

The first case affects rather the integrated branch or pig-iron route, whose products with higher added value are exported over greater distances whereas the second affects rather the electric branch which is directly affected by the rise in electricity prices.

There have not been many economic studies attempting to evaluate the additional cost of the carbon restriction on production costs. We shall cite:

- the study carried out by Julia Reinaud[52], of the International Energy Agency, whose results may be summed up as follows: the acquisition of additional emission rights covering, depending on the scenario, 2% or 10% of production, would lead to an additional cost per tonne between 0.7% and 1.3% for the pig-iron route and between 0.8% and 0.9% for the electric route.
- That carried out by Oxera for Carbon Trust results in higher figures, in particular for carbon at ¾25 a tonne, which would cause a 7.3% increase in the coil price to realise the same profit.
- The study carried out by the OECD[53] on the basis of a tax of $US25 per tonne of CO_2 finds a drop in OECD production between 9% and 12% mainly affecting pig-iron-route installations and also highlighting that the effects would be greater in the medium-long term.

All in all, if the additional costs are relatively modest, it remains no less the case that the competitive advantage thus created for producers situated in countries without the carbon constraint is real. To this loss of competitiveness would be added the risk of replacing low-carbon-intensity steels produced by the electric branch with high-carbon-intensity steels produced by the pig-iron route, originating in China in particular, or the opposite of the effect sought ("carbon flight" phenomenon).

4.4. The question of emission quotas as a research incentive

The principle underlying the "cap-and-trade" system is to give the steel producer the choice between paying for its emissions and making investments to reduce their level and make corresponding savings.

For several reasons, we do not observe this reasoning in steel producers.

In an area where technical progress is decisive for the course of CO_2 emissions, the research and development effort of European iron and steel industry is seen to be particularly weak compared with other industrial sectors.

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[52] Julia Reinaud, *Industrial Competitiveness Under the European Union Trading Scheme*, AIE, 2005.

[53] Environmental Policy in the steel industry: using economic instruments, OECD, 2003.

Thus the R&D investments of the Arcelor group, one of the iron and steel groups with the most invested in R&D, only amounted to 0.42% of 2005 consolidated group turnover. With the formation of the Arcelor-Mittal group, this proportion would automatically reduce to 0.3%.

To date, only the existence of the European ULCOS (ultra-low-CO_2 steelmaking) research programme, whose initial results give hope for a reduction of between 20 and 30% in carbon emissions per tonne, constitutes a concrete factor allowing hope for results in the future. However, Mittal Steel was not among the 48 producers who accepted sharing in the financing of Ulcos, while Arcelor took on the role of undisputed leader in this research programme.

Financed equally by manufacturers in the sector and public authorities, ULCOS is an integral part of the European technological platform Acier which was launched in 2004 and which integrates the network of researchers of the old CECA treaty, the customers and users of steel and union organisations.

The re-evaluation for each period of the emissions quotas granted leads to the nullification of the efforts made during the preceding period; when this period has a limited duration of 4 years it is had to see what sort of comprehensive investment program could pay for itself over such a short period.

In the current system, nothing indicates that the sums realised by a reduction of the emissions saved are allocated to R&D, quite on the contrary....

The lack of visibility on the period beyond 2012 only worsens the gap between an iron and steel industry which professes its will to find more satisfactory but for the time being undefined solutions and a policy conducted on the European scale which seeks its marks in various sectors with very different technical and economic constraints.

To conclude on this point, the link between the commercialisation of insufficient and surplus emission rights and R&D efforts is currently not at all established. It would be advisable to rapidly forge this link in order to give the European iron and steel industry a competitive compensation in the form of the quality of its products and processes for the additional costs borne.

4.5. The various levels of response

Negotiations for the post-2012 period

The prospect of integrating certain zones into the carbon-restriction economy is a first possible response offered by post-2012 negotiations, and it is strategic for the survival of the Kyoto Protocol in spirit if not in fact.

The relative isolation of the European Union on this subject has been highlighted by the creation of the Asia-Pacific partnership on clean development and climate led by the opponents of Kyoto, the USA, South Korea and Australia.

It has also been joined by countries like China and India, as emerging countries having signed the Kyoto Protocol, but also by Japan, an industrialised signatory. That is to say, 6 countries representing a production of 650 MT of steel in 2005. By comparison the Kyoto Protocol applies in the form of a carbon constraint on a production of 350 MT of steel.

Dissociating production level from carbon restriction in Europe

One of the critiques addressed by European iron and steel makers at the current emission rights system is its “cap-and-trade” organisation; in other words, the fact that allocations of emission rights limit the level of production benefiting from free rights. Beyond that, the company must acquire rights on the market.

According to us, it is possible to set targets for greenhouse gas emissions which are not linked either to the capacities or to the outlets of each unit of production. The current rule effectively favours all opportunity calculations both in negotiating quotas with the government as a function of predicted production and in running each unit according to economic conditions.

The “cap and trade” ought to be applied to a ratio of tonnes of CO_2 to tonnes of steel produced and not on the tonnage, so that the effort actually relates to reducing CO_2 emissions independently of optimising the level of production.

Following the example of the current Belgian system, the level of emissions covered by the quotas would be defined according to the best available technologies.

Under these conditions it appears possible to set a progressively decreasing level of CO_2 emissions per tonne of steel in the next twenty years.

Linking the allocation of emission rights to research efforts

On top of the preceding, for emissions quota trading to produce a real incentive for research and development, one ought to:

- give industrialists longer periods during which the emissions rights would be determined in advance.
- forge a much stronger link between the free emissions rights allocations and the research and development effort undertaken by each iron and steel maker. In this way the iron or steel maker investing in the long term ought to be allowed to get the same advantages as those who lower their emissions by short-term adjustments.

The possibility of an adjustment at the borders

A tax at the borders to be applied to steel imports from producers not subject tot he carbon restriction is a complementary lead to be considered. It would allow the correction of the competitive imbalance of the carbon constraint for steel producers situated in the zone covered by the Kyoto accord.

However, this tax has the drawback that it seems difficult to implement in the framework of the situation created by the emissions rights markets for the same reasons as previously mentioned in § 3.3. In fact, the treatment of imports ought to be identical to that of production from within the zone.

An adjustment mechanism at the border based on reference standards (benchmarks)

An alternative solution would consist of fixing a benchmark which would be different for each branch of production, electric or pig-iron. This norm would be based on best CO_2-emission practices over a defined area not allowing for variations between installations.

Under this mechanism, for each tonne of steel imported, for each kg of CO_2 over the benchmark, the importer would be obliged to purchase emission rights on the European CO_2 exchange at the going CO_2 price on this market.

Thus the carbon equivalence between steels produced in Europe and imported steels would be respected.

For this measure to be applicable, one would need to ensure the traceability of steel products as a function of the production branch and for that to give a CO_2 content to each steel product.

This system of regulation would have the advantage, not only of favouring the functioning of the European CO_2 market, but also of not contravening the rules of the WTO, which recognises the justification of the flexible mechanisms of the Kyoto Protocol.

A clean development mechanism (CDM) without its potential paradoxical effect

The clean development mechanism provided for under the Kyoto Protocol, through the ability to acquire emission rights by investing in the reduction of emissions in emerging countries, offers real investment opportunities at less cost in the modernisation of the most polluting iron and steel works in emerging countries like China.

Today, of a total 420 projects registered, there are 16 relating to the production of pig-iron and steel which represent an emission reduction of 3.2 MT of CO_2 per annum (2.9% of the total of all CDMs). The projects most often consist in the utilisation of gases emitted by the production process for electricity generation.

But wouldn't these investments have happened anyway, that is, without the carbon constraint? Without a doubt, and the financial advantage of the CDM provides a new impetus. In this framework, the carbon restriction (all other things being equal) has an accelerating effect on the delocalisation of investments in the world iron and steel industry.

The finance thus obtained therefore ought to be balanced against the application of minimal social standards so as to integrate the clean development mechanism into a sustainability movement combining social and environmental aspects.

4.6. Prospects for iron and steel for 2020 / 2030

Emerging investment strategies

The growth of Asia can only be confirmed in the next few years. After China, whose growth has been awaited for several years, India will, in different ways, reinforce the economic growth of the continent.

The question of Russia remains open, particularly in the case of its joining the WTO, which would free Russian steel producers of quotas on their exports to Europe.

Without being able to read the crystal ball of iron and steel in the new millennium, the investment projects currently launched and whose production will be supplying the transformation markets from 2010-2015 give hints as to the future of the sector in the years 2020-2030.

First, we observe the growth of projects which combine the exploitation of deposits of raw materials, essentially iron ores and coking coal, with liquid phase for the production of semi-finished products, slabs or billets. These new production sites built on the seaboard bring together traditional blast furnaces with an oxygen converter and a hot-rolling mill.

This new growth in production by the traditional route is the result of several developments, including:

- the growth of consumption and production is happening essentially in the emerging countries the first phase of whose development is achieved with a high steel content;
- ferrous scrap supplies in these countries, as in the developed countries, are now exploited to their maximum, which does not allow extension of the electric route as a possibility for increasing production capacities. New iron is required;
- the oligopoly of raw materials producers invites iron and steel producers to increasingly control their sources of raw materials
- to this is added an expected increase in electricity prices greater than that in the price of coal, the traditional energy source of the iron and steel industry, which gives a new competitive advantage to the pig-iron branch compared with the electric branch

Taking account of these factors, Brazilian producers today, but also Russians tomorrow and Indians the day after, will be in a position to offer slabs and billets at competitive prices in European ports, on the pattern of the US and Canadian steel industries whose supplies come increasingly from semi-finished products imported notably from Brazil.

At the present time, more than 37 MT of investments in new production of slabs is programmed in Brazil; these are mostly intended to be transformed into coils and into high-added-value products in the developed countries.

In the same way, India, because of its richness in iron ore, is currently seeing the birth of numerous projects to increase steel production capacity by the pig-iron route. The investments are essentially still to be confirmed, particularly in the state of Jharkhand, and their schedule is less advanced than that of the Brazilian projects.

Thus, progressively, an international slab market could be structured at the 2020-2030 time horizon.

This will result in an increasing division of labour between the liquid phase producing slabs, which have high demands for energy and raw materials, and the low-energy-intensity downstream transformation division close to market outlets.

In these conditions, steel production in developed countries is confined to adapting it to customer needs.

This development is encouraged by iron-ore producers such as the Brazilian CVRD, in a strategy of climbing up the processing chain to increase the added value resulting from the transformation of the ore into steel.

In this sense the risk of delocalisation of the liquid phase towards the countries producing the raw materials for steel production is real in the time-scale of the next ten years.

The maritime model of iron and steel production (importing raw materials by ship, production on the seaboard and transformation and distribution on the continent) developed by Arcelor in Western Europe is thus faced with the appearance of new competition.

Contrariwise, the continental iron and steel industry may find itself stronger as a result, if it has available a competitive continental autarky in its raw materials procurement.

Unresolved questions

The iron and steel industry is both highly capitalistic and cyclical.

Considered as the basic material for the economic material of a country, steel has experienced, over the last 30 years, a continual fall in its relative price level which has often been higher than the productivity gains realised by industrialists. The steel-using industries have thus been able to found their development on cheap steels. For producers, this has often resulted in the need for public support as the only way to make up for the lack of profitability.

The privatisation of iron and steel enterprises has progressively invalidated this economic reasoning, at the very least in Europe.

Chinese development, which is behind the new paradigm of the iron and steel economy at the beginning of the 21st century, remains, however, totally based on various types of public support.

This development has allowed for some 5 years now a temporary obliteration of the steel economic cycle in Europe and in the world, the duration of which is currently unknown.

Some compare the current phase to the period 1950-1960 when the Japanese economic recovery had carried the economic growth of the region for nearly a decade.

Will the much-awaited and -feared return of the cycle be manifested by a lowering of prices below cost price for some producers?

Will it be strong enough to call into question the programmes of investment in capacity increase mentioned above?

Without being able to answer these questions definitively, several elements are to be taken into account:

- the strategies of iron and steel groups in the developed countries currently consist of combining reducing their production levels with a lowering of their prices, unlike earlier practices with favoured adjustment through prices. This change must be highlighted because it involves a profound change in the management of capacity and production
- a great number of investment projects are low-cost projects for the most sound and often form part of a strategy of increasing added value for iron-ore producers and as such they will certainly be successfully completed
- the threats of overproduction are currently essentially due to China, which on one hand is not a low-cost country in the steel-production sector and on the other has major reserves of redevelopments of completely obsolete units. If, in recent times, the announcement of these

redevelopments has not yet had convincing effects for reasons of social support, there is no doubt that these units are condemned in the medium term (see FEM China study)

To conclude on this point, to the extent that there is no question of decreeing unending expansion in steel production, the current topography of the sector allows us to affirm that there are major flexibility factors which allow us to foresee the economic future without major disruption.

It also seems that the Asian economies are on the path to economic growth, with the corollary of a strong increase in the need for steel, especially during the initial take-off phase.

Subject to the consideration of the reduction of CO_2 emissions as a strong medium-term constraint.

Technologies reducing CO_2 emissions

Advances in energy efficiency

In reality, many iron and steel works have the potential to reduce their CO_2 emissions, through the improvement of their energy efficiency alone, of between 25% and 35%, or even beyond, which would make possible, accor ding to the IEA, a total reduction of 2 00 MT of CO_2 (Energy Technology Perspectives, Scenarios and Strategies to 2050. International Energy Agency 2006)

What is more, if we examine the minima required to achieve steel production at the various stages of each branch, we find (table below) that the standards currently accepted by the western world's iron and steel producers in both energy consumption and CO_2 emissions can be very distinctly improved.

The reduction of CO_2 emissions could thus reach, according to these data, between 30% and 58% for installations at the common technological level in the developed countries.

New technologies under development

By 2030, the iron and steel sector will not be turned upside down by revolutionary new technologies, but will pursue the advances embarked on in the last few years.

Substitutes for coke in blast furnaces

The injection of coal as a partial substitute for coke in blast furnaces allows CO_2 emissions to be reduced. It is estimated that nearly 250 kg of coal per tonne of material can be fed in. This results, according to calculations made by technical experts, in an energy gain coupled with a reduction in carbon emissions.

Table III.36. : Energy consumption and minimum required per process : reduction potential of CO_2 emissions

Product / Process	Consumption GJ/t	Minimum GJ/t	Current emissions t/t	Minimum t/t	Reduction potential %
Liquid pig iron	13-14	10,4	1,45-1,56	1,16	20-26
liquid electric iron	2,1-2,4	1,6	0,36-0,42	0,28	24-33
Steel flat bars cold rolled	2-2,4	0,9	0,11-0,13	0,05	55-62
Steel flat bars hot rolled	1-1,4	0,02	0,17-0,24	0	98
Total pig-iron	**16,2-17,8**	**11,32**	**1,73-1,93**	**1,21**	**30-37**
Total electric	**5,1-6,2**	**2,52**	**0,64-0,79**	**0,33**	**48-58**

source: Fruehan et al. 2000 in IEA 2006

Table III.37. : Technology perspective of coal injection

Coal injection	2003-2015	2015-2030	2030-2050
Stage in deployment	commercial	commercial	commercial
investment cost (US$/t)	50-55	50	50
Reduction in energy consumption	5%	7%	10%
Reduction in CO2 emissions *(GT/year)*	0-0,05	0,05-0,1	0,1-0,2

In total, this is 100 MT of CO_2 emissions which could be avoided by 2030.

Another lead consists of injecting waste plastic, a technique developed in Japan and Germany. The gain appears to be essentially in the form of energy efficiency.

Direct melting or reduction technologies

The have been under trial for several years now and are progressing under two constraints: investment in new installations on processes which are not yet fully mastered. The Corex process is thus subject to advanced research with has given birth to 4 factories in the world to date, to which a few additional projects under construction should be added. The combination with feeding pre-reduced iron is also possible.

The investment costs are high, $US359/tonne, which limits the extension of these techniques.

The ULCOS programme

The Ulcos project takes part in the development of these technologies to reduce CO_2 emissions and without doubt constitutes the European initiative of reference in the area of industrial policy adapted to a sector. Reductions of the order of 20% t0 30% are expected, obtained by reinjection of gases into blast furnaces. The efficacy of this technological solution ought to be able to be verified in the next few years with possible expansion to the industrial scale by 2020.

Adopted in December 2004, the strategic research agenda of the European technological platform for steel offers a global vision of innovation and initiatives in R&D which allow the pursuit of the objective identified as a clean, safe and sustainable iron and steel industry. ULCOS also involves the unions and training issues, in line with CECA.

A budget of ¾800M is allocated to the priorities of the period 2007-2013. In total the estimated budget is ¾4.7 billion over 15 years over the duration of the agenda.

Financing is in origin both private and public, from European, national and regional institutions.

4.7. Low-carbon steel: a material of the future for the European steel industry

We propose two scenarios, to illustrate the choices which may be made by those in charge of the European iron and steel industry and by public authorities in setting industrial policy and the effects on employment.

A "business as usual" scenario, which continues the developments described above, with profound transformations to the sector over the next 20 years but not taking any particular account of the carbon constraint.

The second scenario envisages on the contrary a strategic break by taking into account the carbon constraint, not just as a by-product of steel production any more, but as a competitiveness objective of the European iron and steel industry of the 21st century.

We note that to our knowledge there do not exist any studies on the effects on iron and steel industry employment of the application of the carbon constraint.

Scenario 1: the risk of a major social and industrial crisis in the next few years

The meso-economic framework

The first sectoral scenario would pursue the trends at work for the last few years, which are:

- stability in EU-25 steel consumption at around 200 MT, with a continued increase in the added value of each tonne used
- progressive pursuit of outsourcing giving the sector an increased flexibility of workforce numbers in regard to production variations and increasing recourse to insecure forms of employment in a sector which was relatively spared in comparison with other sectors of metallurgy and of the economy
- reduction of the production capacity of pig-iron without a proportional reduction in the number of blast furnaces in operation, accompanied by a major worsening of the

balance of trade through an increase in imports

- R&D effort still just as weak on the part of iron and steel groups even if the support of public authorities allows some results to be obtained through the ULCOS programme
- continuation of globalisation of steel producers and of the concentration of the sector at the global level and increasing transfer of the liquid phase into countries with low raw-material costs
- irremediable loss of employment in the sector but also and especially with the many suppliers and subcontractors, dragging some local labour markets into a deep economic and social depression.

Social and environmental risks

The carbon constraint does not seem destined to play a decisive role until

- the prices of electricity and scrap are so high that they will degrade a part of the European electric branch; this phenomenon occurs whenever the cost price of pig-iron is lower than the purchase price of scrap on the market, as was the case during 2006.
- the quotas attributed to pig-iron and steel production sites are reduced progressively, leading to flexible production-level management based on economic conditions.
- The carbon constraint constitutes an objective competitive disadvantage for the European iron and steel industry compared with those that do not bear the same constraints, leading to a reduction of steel production in Europe and an increasing balance of trade deficit.

The carbon constraint feeds and worsens downward employment movements in the sector at the quantitative level and strongly degrades their qualitative evolution, inducing:

- the proliferation of subcontractors at the heart of the production process with all the risks induced by the dangerous nature of manufacturing procedures,
- the growth of insecure employment on site which will move the sector from flexibility management through internal mobility to increasing external mobility
- an increase in the risks to product quality and possible consequential losses of added value

Quantifying job losses

For a quantitative evaluation of employment movements, for reasons made clear above, it is particularly tricky to put forward figures which at best would only give account of the jobs covered by the collective agreements of the European iron and steel industries.

Currently, in some iron and steel units no less than a third of the total jobs are occupied by employees of outside companies and are therefore not recorded as iron and steel industry jobs.

The situation differs between European countries, but we may estimate that the figure of 20% of all direct jobs outsourced approximates the reality of the sector today.

This said, we should also distinguish those jobs which depend on the hot liquid phase from those which depend on cold transformation. To our knowledge no statistics are available on the subject at any level of information.

To bypass this limitation, we shall mention the following factors:

- on one hand jobs in iron and steel companies declared as such always comprise workers with hot metal, the liquid phase which are the traditional jobs of steelworkers, to which are to be added office jobs, support and R&D functions and, in the majority of cases, only a part of cold transformation
- on the other hand a large number of transformation jobs are based in subsidiaries or are even not recognised as steelworker's jobs, such as in wiredrawing or tubemaking.

Starting from our knowledge of the sector, we can however ascertain that around 50% of the jobs in the sector are directly or indirectly linked to the hot phase or the liquid phase which comprises principally:

- a complex allowing the preparation of the load for blast furnaces
- a coking plant transforming coal into coke
- the blast furnaces for pig-iron production
- the converter and its continuous pour
- the hot-rolling mill for the production of slabs or billets

Applied to the European iron and steel industry the threat therefore hangs over a total of 175,000 jobs corresponding to the production of 200 MT of steel

At the 2030 time horizon, the delocalisation of 50 to 75 MT of slabs outside the European Union, or the equivalent of 25% to 37% of current production, is possible, i.e. an impact of 45,000 to 67,000 direct jobs, to which 9,000 to 13,000 outsourced direct jobs are to be added, that is, a total of 54,000 to 80,000 direct jobs.

Now, taking account the qualitative impact mentioned previously, we may estimate that the level of insecurity could double in the period and reach 40% of permanent jobs through subcontracting, recourse to temporary employment, by employing trainees in the services least exposed to the occupational dangers of the steelworking. In total, insecure jobs would account for 30% of the workforce employed in the units.

In total between 80,000 and 120,000 direct jobs are threatened of which a third relate to changes in collective agreements corresponding to the search for greater flexibility. (80 000 = *54 000* + *[(175000-45000)*0,2])*

This will result without doubt in a worsening of working conditions and increased risks to health at work by transferring the risks to subcontracting companies or to outsourced jobs.

This development will be greatly facilitated by the natural attrition of employees currently covered by the collective agreement. The European iron and steel industry is in fact entering a period of high turnover in its employees which poses a threat to productivity, which for a long time has been helped by a high level of stability in its workforce. The replacement of more than 50% of employees in a very short time in some units is already posing problems when it is not accompanied by measures organising the transfer of individual and collective know-how. The additional fragility brought to the sector by the carbon constraint can only aggravate this situation.

We do not broach here the impact on induced jobs which tell the story of the way the sector feeds local labour markets and regions of implantation.

Scenario 2: definition of a low-carbon strategy in the European iron and steel industry gives the sector and its jobs a future

The meso-economic framework

The general hypotheses in common with the 1st scenario are the following:

- stability in EU-25 steel consumption at around 200 MT, with a continued increase in the added value of each tonne used;
- continuation of globalisation of steel producers and of the concentration of the sector at the global level.
- Continued bidding up of raw materials;
- Progressive pursuit of outsourcing

This scenario, on the other hand, supposes that European producers confirm, even increase, their technological excellence in the production of steel with limited emissions.

The modifications to be introduced to the mechanism

The factors favourable to a low-carbon strategy would consist of:

- linking the allocation of emission rights to the producers' R&D efforts by establishing an equivalence between investments allowing short-term reduction in CO_2 emissions in production units (energy efficiency, development of raw materials used as feedstock) and those on the long term (R&D)

- sizing the reduction of emissions quotas allocated per installation with the rate of return on investments and therefore transforming the reduction of greenhouse gas emissions into a conditional profit opportunity for European iron and steel companies. The period for which rights are allocated should therefore be extended to 10 years at least.
- setting a standard for CO_2 emissions by production branch (pig-iron route and electric route) which would allow, beyond the particularities of each installation, each steel product to be given a CO_2 quality wherever it came from
- cancelling the impact on the price of electricity of the carbon constraint of steel producers by the electric route so as to favour the production of low-carbon steel which has the advantage of commercialising a secondary raw material through steel recycling
- introducing regulation on the importation of steel products which, through the CO_2 quality, allows the carbon cost to be rebalanced for steel consumed in the European Union. The rebalancing of this carbon cost for imports would be effected by purchasing emission rights on the market. This would thus compensate for the loss of competitiveness of the European iron and steel industry due to the CO_2 emissions reduction policy.
- modifying the governance of the sector by reintroducing social partners and other interested parties into the steering of the carbon constraint.

Impact on employment

The totality these measures does not allow employment in the iron and steel industry to be maintained at its current level because of the structural nature of certain changes in the sector such as the price of raw materials and the outsourcing of an increasing number of previously integral functions.

On the other hand, the maintenance of production capacity resulting mainly from the lowered commercial pressure from high-carbon steel imports and the dynamics of investment in R&D as well as in pilot units and innovative industrial units allows the negative impact on employment in the sector to be reduced.

Under these conditions, it is estimated that 50,000 direct jobs, internal and outsourced, will be able to saved (compared with the 80,000 threatened) in the European iron and steel industry, mainly in the West, because apart from the rebalancing applied to imports, steel production by low-carbon processes has become a competitive advantage for European producers.

This competitive advantage is a way of getting companies and their interested parties involved with the voluntary strategy conducted by the European Union in the fight against greenhouse gas emissions for many years.

In Eastern Europe, there is already room for progress in reducing greenhouse gas emissions for the totality of existing iron and steel units, opening the possibility for these units to benefit from surplus emissions rights to sell and thus facilitate their modernisation.

What CO_2 emission reduction for the European iron and steel industry?

With the application of a CO_2 emission standard per tonne of steel, do we guarantee an overall reduction in the emissions of the European iron and steel industry, and in what proportion?

If there is no doubt that eventually, given the targets of emission reductions greater than 50%, a breakthrough technology is indispensable in steel production, the period 2010-2030 will be a period of transition during which continuous reductions must be able to be effected.

As we have seen earlier, available technologies allow us to envisage substantial reductions which give an attainable target of 1.2 t of CO_2 per tonne of steel, a reduction of a third compared with current emissions.

European steel production has been stable for some years, and nobody doubts that the years to come will not see European steel production extend to export, essentially for reasons of price-competitiveness. It is rather the reverse phenomenon which risks coming about due to increased imports.

The table below allows us to visualise a hypothesis of a 50% reduction in CO_2 emissions of the sector over the period 2005-2030.

The hypotheses which governed the construction of this table are:

- an average level of emissions of 2 tonnes of CO_2 per tonne of steel in 2005, which is corroborated by various sources with deviations depending on the installation
- stability of European production of pig-iron-route steel at the level of 120 MT
- a reduction target set by European public authorities in the framework of uniform NAPs in all countries of the Union and applying to all installations
- the implementation of technologies already available or which will be so in the near future up to 2020
- the period 2020-203 0 will be crucial to developing the technological breakthroughs indispensable to subsequent emission reduction

4.8. Conclusions and recommendations

The iron and steel industry is one of the industrial sectors most concerned by CO_2 emissions. Apart from energy production, iron and steel is the principal industrial emitter of CO_2, ahead of cement works (3%), aluminium (2%) and paper pulp (1%).

Jobs in the sector, as a globalised industry, are more and more subject to delocalisation. In this context, there is no doubt that without reworking the emissions limitation policy currently in effect, the risks of delocalisation are real and will have a certain impact on the level of employment in the sector. It is quantified at a total of 54,000 direct jobs, internal and outsourced.

For if it is not the application of the Kyoto Protocol that is behind the risks currently hanging over employment in the European iron and steel industry, it is prolonging them, provoking their acceleration by potentially erecting an obstacle to the competitiveness of the sector in the course of the next few years.

A low-carbon industry policy applied to the iron and steel industry, extended to industrial production and not limited to R&D alone, would allow the impacts on employment to be limited and the majority of the jobs potentially threatened by the delocalisation of the liquid phase to low-cost countries without carbon constraints to be preserved.

Table III.38. : Reduction of CO_2 emissions of the European steel industry at the horizon 2020

	2005	2010	2015	2020	2025	2030
T of CO2 per T steel	2	1,8	1,6	1,4	1,2	1
European production (MT)	120	120	120	120	120	120
Tones of CO2 emitted (MT)	240	216	192	168	144	120
		-10%	-20%	-30%	-40%	-50%

The European and global iron and steel industry has entered a period of transition before the setting in place of breakthrough low-carbon technologies in steel manufacture.

This movement should be supported so as to maintain the jobs and know-how of the second-biggest iron and steel industry in the world after China, the European iron and steel industry still mobilising a large number of jobs (370,000 in 2004), distinctly more substantial than the other industrial sectors which emit greenhouse gases (cement works, aluminium, paper pulp, glass, ceramics...), and in particular often defining the economy of whole territories.

The technologies are available, the financial means already released. They need to be redirected to allow the European iron and steel industry to make the most of its major, if not unique, advantages in the fight against greenhouse gas, and in particular CO_2, emissions.

For the paradox would reside in the replacement through wild competition of low-carbon steel producers by high-carbon steel producers, the opposite of the intended effect.

Tools and mechanisms of a new European industry policy crossing sectoral and transverse dimensions (R&D, training, market instruments founded on a system of standards...) compatible with WTO rules (which would recognise climate change as a universal public good) are to be introduced in the service of the public interest objective of fighting climate change.

The European iron and steel industry, which has the rich experience of 50 years of CECA (which expired in July 2002), could be the pilot sector to trial this new low-carbon European industry policy for all greenhouse-gas-emitting industries in Europe.

The European ULCOS R&D programme is only the first brick in this edifice to be invented and constructed urgently to involve the industrial sector in the response to this challenge, respecting the balance of the three pillars of sustainable development (environmental, economic and social).

This new industry policy in connection with the European sustainable development strategy can only respect this balance and be effective if it allows union organisations and the workers' representative bodies (European Enterprise Committee, European Sectoral Social Dialogue Committee for Steel) to play an active role, as was the case within the consultative committee of CECA.

5. The cement sector

5.1. The economic and social situation in the European cement sector and its potential for reducing CO_2 emissions in the short and medium term

The economic and financial issues in the European Kyoto mechanisms in the cement sector

The cement sector, along with the iron and steel industry, is the industry generating the most CO_2 emissions at European and global level; they account respectively for 5% and 6% of total emissions. This proportion will tend to increase in the short to medium term under a BAU (Business as Usual) scenario given the trend over the past decade in the sector for sustained growth in cement production.

Between 1999 and 2004, global cement production increased in terms of tonnage by 37% and in 2005, the trend continued (+7%), reaching 2.3 billion tonnes, thereby releasing some 2 billion tonnes of CO_2 emissions worldwide, and achieving sales worth 87 billion dollars in 2005.

Over half of the global CO_2 emissions from the cement sector are the result of cement production in China (the world's number one producer) and India (the second largest producer):

- Although the world's worst performer, in terms of the intensity of CO_2 emissions per tonne of cement produced, is the USA (3rd biggest producer in the world), with almost 1 tonne of CO_2 emissions per tonne of cement produced, the European cement industry does not have the world's cleanest hands in terms of pollution per tonne, with an average level of 0.84 tonne of CO_2 per tonne produced. The best performers in this field are Japan, the world's 4th biggest producer, with a score in the year 2000 of 0.73 tonne of CO_2 per tonne of cement produced, and Australia and New Zealand with 0.79 tonne of CO_2 (Source Batelle-CSI-WBCSD).
- Japan's rating can be explained essentially by the better performance of its cement sector in terms of energy efficiency (3.10 megajoule per kg of clinker, or 23% higher than Europe's performance) and in terms of the intensity of clinker per tonne produced (0.80).

Within the 25-member EU, 6 countries dominate the production of cement and account for 71% of the total CO_2 emissions

European cement production (EU25) has seen substantially lower growth in recent years than world production (+7% between 1999 and 2004 and +1% in 2005), reaching about 239 million tonnes in 2005, or 11% of world production, corresponding to 10% of global CO_2 emissions in the cement sector.

Within the 25-member EU, 6 countries dominate the production of cement, accounting for 73% of Community output in 2004.

Europe's biggest national producer is Spain, with over 50 million tonnes of cement produced in 2005 (+8% in 2005 after +30% between 1999 and 2004), making 20% of Community production, ahead of Italy (19%), Germany (15%), the United Kingdom (5%), France (9%) and Poland (5%).

This group of Europe's 6 biggest cement-producing countries is also the group of countries which are the biggest consumers of cement (representing ¾ of the European cement market).

The key factor in this correlation between national cement production capacities and national markets is the need for proximity between the supply side and the demand side for cement, in order to satisfy the latter in terms of quantity, quality and deadlines. The output of a cement works in the EU is almost always destined for local consumption. The point is that the transport costs, and above all the cost of road transport, mean that little cement is exported.

The strong growth in the consumption of cement has been only partially satisfied by national production capacities which have been declining

The strong growth in the consumption of cement in certain European Union countries over a number of years (Spain +25% between 2000 and 2004, Italy +21%, France +6%) has been only partially satisfied by national production capacities, which have declined following a process of restructuring and rationalisation which resulted in the closure of 27 cement works in the EU25 between 1999 and 2004 (or 10% of the European stock), and countries have had to make increasing use of imports (+20% at EU25 level during this period).

Five of the six major cement producing and consuming countries in the EU25 are also the five major importers.

In 2001, cement imports covered 12% of EU25 cement consumption, while by 2003, this rate of recovery had risen to 14%, which is still quite modest; given the difficulties involved in transporting them over long distances and by land, imports are essentially limited to those coming from the countries in the Mediterranean basin (Turkey and Morocco).

Following the healthy climate on the European and global cement market, and the over-allocation to the cement sector of CO_2 emission quotas, the major producers in the sector have been enjoying excellent economic and financial health over recent years

The global cement leaders, Lafarge, Holcim and Italcementi, for example, have seen their respective turnover in 2005 rise by 11%, 9% and 15%, and in the first nine months of 2006, they enjoyed sustained growth of 22%, 10% and 12%. Their operating results (EBIT) would be the envy of many industrial concerns, standing respectively at 21%, 18% and 19% of turnover.

This steep rise in results is the consequence of a sound economic climate in cement consumption both in Europe and globally, combined with a drastic restructuring process.

The European cement sector is certainly an energy-intensive sector, and one which is intensive also in terms of CO_2 emissions, but nevertheless paradoxically in 2005, this sector was a winner in the European system for the allocation and trading of CO_2 emissions (the Cap & Trade ETS), in terms of the quantities awarded free of charge. The point is that the cement sector was over-allocated some 7.2% of CO_2 emission quotas, representing a surplus of 12.1 million tonnes of CO_2 in emission rights (as against a total of 168 million tonnes of CO_2 in 2005 emitted by the EU25 cement sector), which meant that with a quota trading at an average of 12.5 euros in 2005, the sale of these unused quotas represented a potential income of 151 million euros, equivalent to approximately 0.9% of the turnover in the EU25 cement sector.

Allocations of emission rights were unequal across the EU countries.

The direct carbon constraint/opportunity administered by the cement groups depends heavily on the geographical structure of their production sites.

Accordingly, the Italian group Buzzi Unicem announced the sale of emissions quotas for the sum of 26.4 million euros in 2005, at an opportunity price of 29 euros/tonne of CO_2 (whereas on 22 January 2007, the rate for the quota had tumbled to 4 euros/tonne). Lafarge published sales of CO_2 emission rights representing some 1% of its EBIT.

This general over-allocation in Europe does nevertheless hide some major disparities between countries. Out of the 12.1 million extra tonnes in 2005, over half is held by German and Polish installations; the remainder of the over-allocations was awarded to cement installations in Belgium (1.2 million tonnes), the Czech Republic (0.8 million tonnes) and France (0.3 million) (source CITL).

Various analyses conducted by carbon investment funds indicate that the groups Lafarge, Holcim and Buzzi Unicem are coming out the winners of the over-allocations granted gratis by the States, thanks to their bases which are largely provided with quotas in central Europe.

So, depending on the geographical structure of their bases in Europe, the situation, the position and the strategy of the cement groups will vary vis-à-vis the European ETS.

On the other hand, Italcementi and Cementos Portland seem to be the losers in the European ETS because of their strong exposure in Spain and in Italy, 2 countries which have to make serious efforts to achieve their Kyoto objectives, but which at the same time are the 2 biggest national producers of cement in Europe, buoyed up by sustained growth in the building/public works sector in those 2 countries.

So we can see that Spain, although it is lagging behind in terms of its Kyoto objectives, has been generous to its cement works (3% of allocations on top) while passing agreements to significantly curb CO_2 emissions per tonne produced between the government and the cement producers (-20%, for example, between 1990 and 2010 in the case of the Swiss group Holcim's plants in Spain).

Until the end of 2007, the surplus emission quotas awarded by the Member States of the EU should be continued with a minor reduction compared to 2005 because of the sizeable growth in production in certain countries such as Poland and Spain.

The European cement sector will remain over-allocated in terms of quotas with a surplus estimated by several investment funds at 5-10 million tonnes of CO_2 within the EU25, with a positive impact on its profitability.

The essential potential problem linked to the European ETS to be administered by the cement sector is its impact on the price of electricity. This impact apparently went from 14% of the production costs of European cement to 25% in 2006, according to an evaluation by Cembureau.

The electricity producers put about 10 euros/Mwh into their prices in 2005 in respect of the carbon cost, leading to an additional energy bill for the cement manufacturers corresponding to 1.5% of turnover in the sector.

But the cement sector has been able to offset this extra electricity cost linked to the opportunity cost of the carbon billed by the electricity companies by implementing several measures: by internally producing the energy required and by increasing the coverage of the electricity produced internally and passing on the additional costs to the customers, which has delivered them excellent income statements.

Yet if the impact of the European ETS on the activity and the results of the cement sector is zero or insignificant (as we saw earlier), how can we explain the positions and the vehement reactions from the industrial players in this sector with regard to this system (which will be analysed in detail in Chapter II), other than by a strategy of resistance to any actions planned in the medium to long term which would run counter to objectives focused on short-term timing and prospects imposed by a more demanding shareholder structure in terms of results and a very rapid return on capital invested.

5.2. The social issues – jobs in the European cement sector

The European cement sector is a low labour-intensity industry

In other words, it mobilised only 53,300 workers in 2003 in the EU25 (compared to the 120,000 workers in the oil refinery sector or the 380,000 employed in iron and steel), in terms of highly capitalistic industries.

In addition, compared to the cement sector at the global level, which mobilised 850,000 workers in 2005 (source WBCSD) for a global output evaluated at 2.3 billion tonnes, the EU25 cement sector is a substantially weaker mobiliser of human resources, with 53,300 workers for a European cement output evaluated at 241 million tonnes in 2005 (or 221 jobs per million tonnes produced) compared to 370 jobs per million tonnes produced at the global level.

The low labour-intensity of the cement industry is reflected in the structuring of the production costs of European cement, characterised by personnel costs accounting for only 21% of production costs (in 2005, source AIE Industrial competitiveness under the EU ETS), whereas the energy and raw materials costs account for 38% of these production costs (fuel 14%, raw materials 10%, electricity 14%).

In 2006, indeed, electricity costs rose from 14% to 25%, thus correspondingly increasing the energy and raw materials costs.

Employment has been constantly declining since 1999

The volume of jobs has fallen significantly from 1999 to 2005 in the EU25 (by -6,290 jobs, or -13%) and from 2003 to 2005 (by -3,650 jobs or -6.4%), with contrasts in trends between countries: (-17% in the UK between 2002 and 2004, -31% in Germany, -9% in France, -22% in Hungary).

This negative evolution in jobs in the European cement sector is the result of a drastic process of restructuring operations marked by a process of rationalisation, site closures and relocations, accompanied by an upturn in imports from cement works based in the Mediterranean basin, to satisfy a European cement market that has grown by 5% (between 2000 and 2004).

For example, 27 cement works closed down between 1999 and 2004 in the EU25 (9 in Germany, 5 in the UK, 3 in France, 4 in Italy and 4 in Poland) and only 2 new ones were built (in Ireland).

In the years ahead, irrespective of the P&M involved in the fight against climate change, the volume of jobs will continue to go downhill if this process of restructuring continues or even accelerates.

More and more highly qualified staff

While the volume of jobs has been slipping for several years in the European cement sector, the level of qualifications of the jobs, on the other hand, has increased, following the evolution of the processes (which have become more complex) and the constant improvement of product quality. All the cement groups have had to beef up their training programmes to allow staff to gain new skills.

5.3. *Evaluation of the potential for the reduction of CO_2 emissions by 2012 and 2030 in the European cement sector*

The technological issues involved in achieving a sizeable reduction in CO_2 emissions in the cement sector by 2012

The cement sector is traditionally one which is slow to innovate (in terms of R&D investment in products and processes and in innovation training programmes), which in the medium and long term is a handicap for the sector if it seeks to adapt in a cost-effective approach in a process of a sharp reduction in CO_2 emissions which might be imposed upon it: this structural weakness is highlighted in the diagnosis made by the Batelle-WBCSD report 'Toward a sustainable cement industry'.

In 2005, in fact, the 2 world leaders in the cement sector, Lafarge and Holcim, respectively earmarked only 0.3% and 0.1% of their turnover for R&D, which is very low and not in keeping with the avowed policy in their communication plan. And the R&D effort devoted to driving down CO_2 emissions by the world leader is put by the latter at 3.4 million euros or 0.04% of its turnover corresponding to its cement activities. Only the Italian group Italcementi invests an R&D budget that reaches the threshold of 1% of turnover (in 2005), with an increase of 6% compared to 2004, having launched an ambitious programme in the alternative manufacturing processes to Portland cement.

Let us remember that the cement sector is responsible for 5% of the European Union's total CO_2 emissions.

At European level, the carbon factor of cement varies in line with a ratio of between 0.6 and 0.9 tonnes of CO_2 per tonne of cement produced, depending on the process used. This carbon factor results from 3 factors:

- the emissions linked to the process
- the combustion emissions
- the clinker/cement ratio

The emissions linked to the process

The preparation of the raw materials at high temperatures, also called decarbonising, during the clinker production phase, is very carbon-intensive and represents approximately 60% of total emissions;

The combustion emissions

The combustion of the fuels used to heat the raw materials is responsible for 40% of the emissions covered by the ETS. To drive down the CO_2 emissions per tonne of cement, actions to achieve a significant reduction in CO_2 emissions in the production of cement will therefore depend both on the method of application of efficient existing production techniques and the scale of the investments in R&D (but also in training) to develop new production techniques which cause less CO_2 pollution, including breakthrough technologies.

This means carrying out actions along two main thrusts:

- energy efficiency: by reducing the quantity of fuel needed for manufacture at high temperatures;
- changing fuel: by using less carbon-intensive fuels such as gas or renewables with no CO_2 as a substitute for oil coke or coal which have a high carbon factor;

The clinker/cement ratio

Reducing the quantities of clinker per tonne of cement, by adding mineral compounds such as gypsum, fly ash or steelworks slag, so as to produce a more mixed cement. Added direct to the clinker, mineral compounds also make it possible to reduce energy consumption, even if the current quality demands on the clinker impose a base level of limestone in the raw material mix of 78%.

Reduction of emissions by a minimum of -30% by 2030 through the implementation of inexpensive conventional measures recommended by the WBCSD

According to the WBCSD, on the basis of a study by the American Batelle Institute, the potential for CO_2 emissions to be reduced in the cement sector by 2020 and definitely by 2030 is at least 30%, which translates into the following package of actions:

- Emissions linked to the process: a reduction of -7% in CO_2 emissions is made possible through more mixed cements.
- Combustion emissions: a reduction of -11% in CO_2 emissions is made possible through improvements to energy efficiency and a reduction of -3% in emissions by greater use of alternative, CO_2-free fuels.
- Compensation/substitution actions in respect of products and other actions could contribute a 12% reduction in emissions.
- Reductions in CO_2 emissions linked to actions on the cement and clinker transport system, or on the more efficient production of low-carbon electricity, would have effects put at only -1% each.

The carbon factor of the cement sector varies substantially from country to country and from cement group to cement group.

In terms of energy efficiency, cement production in Japan delivers the best performance (3.1 Megajoule per kg of clinker in 2000, compared to 4.04 in western Europe).

In terms of the rate of use of alternative CO_2-free fuels, cement production in the Netherlands (83%), in Switzerland (48%), in Germany (42%), in France (34%), in Belgium (30%) and in the Czech Republic (24%) performs better than the average across EU25 cement works and countries such as the United Kingdom (6%), Hungary (3%), Finland (3%), Italy (2%), Spain (1%) and Poland (1%).

The carbon factor of the cement sector also varies between cement manufacturing groups, depending on the performances in terms of the rate of use of alternative CO_2-free fuels, or the intensity ratio of clinker/tonne of cement. Globally in 2005, Europe's most efficient cement group in terms of carbon factor was the Swiss group Holcim, with a rate of 0.635 tonnes of CO_2/tonne of cement, ahead of Cementir (0.645 tonnes of CO_2/tonne of cement), Cementos Portland (0.647 tonnes of CO_2/tonne of cement), Lafarge (0.670 tonnes of CO_2/tonne of cement), Buzzi Unicem (0.677 tonnes of CO_2/tonne) and Italcementi (0.688 tonnes of CO_2/tonne)[54].

The strategic issues in the new technologies for the drastic reduction (factor 4) of CO_2 emissions linked to the cement manufacturing processes

What are the promising new technologies which can deliver a sharp reduction in CO_2 emissions in the not too distant future?

Voluntarist policies and measures in terms of R&D might, by 2030, generate some cost-effective technological breakthroughs.

Potential technological breakthroughs relate not just to reductions of CO_2 emissions linked to substitute energies but also, and above all, to reductions in the emissions linked to the manufacturing processes:

- in the medium and long term, the new CO_2 capture and storage techniques adapted to cement works;
- in the short and medium term, substitution solutions for traditional Portland cement (CO_2 emitted during the decarbonation of the limestone and the production of clinker).

As to the new binders replacing the clinker, several new technologies are promising and are the subject of R&D projects or in some cases even already at the experimentation stage, which might help to drive down CO_2 emissions significantly (by as much as -80%).

Cements based on pozzuolana (geopolymers, already developed in the framework of R&D programmes – Geocistem – financed by the European Commission), and cements based on (sulfo) aluminate of calcium (the Italian group Italcementi has devised this new type of binder and plans to start bringing it to market late in 2006) are already being industrialised or even marketed.

Other new binders with major development potential are cements based on calcium sulphate and ceramic-based cements.

Finally, the longer-term 'eco-cements', an Australian invention (TecEco), represent a very substantial issue, beyond the CO_2 emissions from the cement works' production processes, because they absorb the CO_2 contained in the air by drying, and make buildings into giant carbon wells.

So in order to adapt with a view to achieving very meaningful reductions (factor 4 type scenario) in CO_2 emissions, there are several options open to the European cement industry:

The use of additives (fly ash, etc) is already widespread and offers the advantage of needing only limited technological adaptation. But with the resistance of the material being linked to the part of the clinker, which cannot go below a certain threshold, it cannot enable CO_2 emissions to be reduced below 40%.

In the short to medium term, the abovementioned 'new binder' technologies are promising alternatives, enabling CO_2 emissions to be slashed (by as much as 80%), and they are all the more plausible because they can be adapted to older factories, using raw materials which are common round the world and also show scientific credibility and technological and industrial reliability which are appreciably higher than the eco-cements.

[54] source: companies and SRI-Cheuvreux.

However, the implementation and increase in importance of the new cement manufacturing processes with much lower CO_2 emissions will face a number of technical, social and economic obstacles

The economic and financial obstacles

The cement manufacturers are uneasy at the introduction of these new technologies, insofar as they have factories at their disposal which are optimised for the production of traditional Portland cement, which is easy to make and not expensive.

The cement industry is a highly capitalistic industry, requiring investments running at 3 to 4 times annual turnover, and the lifespan of a typical factory is 100 years. Consequently, it is unlikely, by virtue of the laws of the market alone, that we will see the introduction of the new technologies in the short to medium term in the regions where the cement industry has already invested on a sizeable scale, such as Europe. The emerging countries would escape this economic and financial constraint, for the building of new factories can be envisaged there, whether or not via the clean development mechanisms (CDM) provided under the Kyoto Protocol.

Large-scale industrialisation of cement production with new binders is the solution which looks the best from both the technical point of view (significant reduction in process emissions and quality of the material) and the economic standpoint.

Financially, however, it may potentially be able to be implemented only via existing plants (as is the case with the geopolymers).

But it is probable that some marginal investments, notably with regard to the transformation and modification of the production units, will be required; the amount of these investments will have a major bearing on the economic viability and the introduction of the new binders by the cement works.

The role of the public powers at national and European level might to some extent change the look of this economic equation.

In addition, the commercial valorisation of the new procedures might be a factor motivating the cement plants to invest in procedure innovation under certain conditions.

The question of standards

At present, these impose strict constraints in terms of the composition of the cements and thus either seriously restrict or even prohibit the setting in place of new procedures. The development of binders which drastically drive down CO_2 emissions thus calls for a complete rethink of the standards in cement, perhaps gearing them more towards structural qualities (mechanical properties and setting times) than towards composition. The challenge posed by the standards issue forces us to settle the question of the mobilisation of many players in the decision-making chain (the industrial, administrative and political players).

The training of managers and workers in the cement sector and in its client sector

The new binders might make the supply side attractive to the client sector, but they will need to be accompanied by training programmes not only for the managers and workers in the cement groups, but also for those in the client sector companies (notably in the fields of building and public works), not to mention individuals.

The crucial issue of the role of the public powers in overcoming these obstacles to the development of the new technologies in the cement sector

It is clear, given all the technical, economic and financial obstacles, that the large-scale exploitation of the cement technologies which drastically reduce CO_2 emissions will not be effective without the existence of a strong political will, taking concrete shape through measures which are binding (quotas, CO_2 rating, the demand for new technologies in the CDM, revision of standards, etc) while at the same time serving as incentives (in the form of public aid for R&D programmes and training programmes, etc).

5.4. The position and strategy of the various parties involved in reducing CO_2 emissions in the European cement sector

The position and strategy of the European cement groups are not uniform, and vary from country to country, in contrast with the actual situation in the European cement sector and its potential for reducing CO_2 emissions in the short to medium term.

The public stances taken by the cement groups and their European professional association Cembureau contrast with the analyses given in Chapter 5.1.

The position of the European professional association Cembureau is distinguished by inflexibility and the planned closures of production capacities and relocations in order to achieve the European objective of reducing CO_2 emissions

In its last activity report, Cembureau thus presents the situation of its members vis-à-vis the European Kyoto mechanisms:

The cement industry, which has a high rate of CO_2 emissions per sales unit, is not in a position to buy quotas at a price higher than 25 euros. Given the increase in demand for cement in many countries, the capped plan (cap & trade) in the emissions trading scheme set up by the European Union provides for a reduction in CO_2 emissions only through the scaling down of production capacities, closures and the relocation of cement works. This approach is clearly inadequate, because it then means that the clinker or the cement has to come from outside the European Union, thus leading to a net increase in CO_2 emissions on account of the transport. In addition, European cement works, 50% of whose production was sometimes destined for export, are in the process of losing their position on the global markets.

What is more, the fear expressed early on by Cembureau that the European trading system (ETS), which came on stream on 1 January 2005, would cause a rise in electricity prices, has unfortunately been realised: on average, the cost of electricity has risen from 14% to 25% compared to the total cost of cement production. This indirect effect is now recognised by the European Union, although it is powerless and incapable of delivering solutions in the short to medium term.

Cembureau warned repeatedly against the danger of seeing the electricity companies raise the price of electricity by passing on the CO_2 cost, while receiving free quotas, even for electricity generated with no CO_2 emissions. This prediction came true in 2005 and has been recognised by all the interlocutors.

From an attitude of resistance...

'Regarding the implementation of the CO_2 emission quota trading system, the Lafarge group considers that the current CO_2 emissions trading system could be more effective and more competitive if it took account of the actions which have been in hand for the past few years.

The competitive gap created by the value of the CO_2 in the European Union's ETS with the rest of the world is a cause of serious concern for the activities of Lafarge, which are vulnerable to imports.

Lafarge is of the opinion that combustible waste should be considered as neutral in terms of CO_2 emissions, insofar as valorising it in cement works contributes towards driving down emissions overall.

Lafarge would like to see no restrictions imposed on recourse to the Kyoto flexibility mechanisms.

The group backs the concept of 'domestic projects' whereby a player is allowed to obtain CO_2 credits when it invests in a project to reduce greenhouse gas emissions on national territory.

We support the setting of reduction targets, but we would argue for them to be compatible with economic growth. In that sense, we support the setting of unit objectives based on technical standards' (Lafarge, sustainable development report.)

... to a voluntarist attitude

Lafarge also focuses in its latest activity report on the renewal of the partnership it established with the NGO WWF in 2001, providing for the latter to monitor the CO_2 emissions and the progress made on reduction compared to the objectives defined:

- reduction of specific net global emissions of CO_2 per tonne of cement by 20% over the period 1990-2010 (in 2005, the situation stood at -12.7%);
- reduction of absolute gross emissions in the cement activity in the industrialised countries by 10% over the period 1990-2010 (in 2005, the situation stood at -8.3%);
- achieving a level of use of replacement raw materials of 10% for the cement activity (in 2005, the figure was 8.5%).

Two main types of actions have been announced: research programmes and a programme of investments in clean development mechanisms.

The Swiss group Holcim, the world n° 2 in the cement business, is implementing a variable-geometry strategy

For example, Holcim has agreed to make a commitment in Switzerland to apply the agreement of industry objectives signed in 2003 between the federal government and the Swiss cement industry employers' association (Cemsuisse) providing:

- the reduction of fossil CO_2 emissions (resulting from the combustion of fossil energy) in the Swiss cement sector by 44% between 1990 and 2010, making a reduction of 586 kilotonnes of CO_2;
- a reduction of 30% in CO_2 emissions due to the manufacturing process for the same period, making a reduction of 738 kilotonnes of CO_2;
- the pegging of the share of replacement fuels at 40% until 2010, despite the uncertainties besetting the waste market.

In the same way, the Holcim group has agreed an arrangement with the Spanish government and the unions (under the national framework agreement to combat climate change) to achieve a 20% reduction in its specific net CO_2 emissions per tonne of cement between 1990 and 2010.

Conversely, the position and strategy of the Holcim group are quite different in other countries such as France.

The fact is that the Holcim management is demanding an increase in CO_2 emission quotas for the French NAP for the sake of its competitiveness and has criticised the arrival in Dunkerque of a competitor, the Luxembourg Gamma Logistics Investments, importing clinker from Morocco, which is regarded as unfair and which would apparently jeopardise 500 jobs in its 2 plants in the Nord-Pas-de-Calais area.

5.5. The CO_2 emissions and employment level scenarios by 2012 and 2030 in the European cement sector

On the basis of the determining factors with an impact on CO_2 emissions, activity and employment in the European cement sector, analysed in Chapters I and II, we have drawn up some job scenarios based on Business as Usual (BAU) and alternatives to BAU by 2012 and 2030.

For all the scenarios, we have started on the assumption of moderate annual growth in European cement consumption (+1 to +2%), but with absorption of the effect of reduced employment through labour productivity gains.

The BAU scenario

The BAU scenario in 2012 and 2030 is perfectly valid if emission reduction measures are not voluntarist but on the contrary lax vis-à-vis the cement sector, and if, for example, the European CO_2 emissions trading system becomes neutral by not operating properly with the price of carbon too low.

Taking over the calculations of the IPTS Institute (for Commission DG Research), the BAU scenario results in a 2.6% increase in CO_2 emissions in 2012, rising to 5.2% compared to 1990 by 2030.

At that point, not only would the P&M in terms of CO_2 emissions not make it possible to achieve the European Union's CO_2 emissions reduction objectives, but at the same time, they would have no positive or negative effect on employment in the European cement sector.

Alternative scenario n° 1, without accompanying policies and measures

This alternative scenario posits that the European CO_2 emissions reduction objectives are achieved within the time frames considered (-8% in 2012 and -30% in 2030) but with a severe reduction in European cement production linked to a large-scale process of relocations, capacity closures and substantial recourse to imports to satisfy European demand for cement.

This scenario likewise assumes an absence of voluntarist policies and measures to accompany the cement sector to enable it to significantly drive down its CO_2 emissions without jeopardising its competitiveness.

This process of reducing European cement production would result from the accentuation of the current trend towards restructuring linked to strategies of rationalisation, relocation and increasing recourse to imports from the Mediterranean basin because of the perverse effects caused by the way in which the ETS operates in the cement sector, penalising the competitiveness and profitability of cement companies in Europe and triggering strategic choices by European cement manufacturers to supply the European market by pollution-causing cement works located outside the European Union and not bound by the CO_2 constraints.

These hypotheses are the ones raised by the European association of cement producers Cembureau (thus expressing the position and strategy of the main cement groups) which, considering the current ETS as leading to widespread perverse effects jeopardising the competitiveness and profitability of European cement manufacturers, take the view that reductions in CO_2 emissions will be achieved only by reducing the European Union cement works' production capacities, closures and relocations.

The automatic impact of such a strategy by the enterprises in the European cement sector should lead to a reduction in activity and employment of 8% in 2012 and 30% in 2030, which would translate into a reduction of some 4,300 jobs in 2012 and some 16,000 jobs in 2030, if we consider that the pace of the destruction of jobs would be equivalent to the pace of the decline of cement production in Europe.

However, even if the strategy of the players in the sector makes such a 'catastrophic' scenario for employment plausible, we consider that if we take into account a raft of economic factors, the increasing power of imports and relocations seriously needs to be seen in relative terms, including in the event that the CO_2 constraints were to weaken the competitiveness of the European cement manufacturers.

Among these factors we might cite all the constraints linked to the relocation process: with the price of sea and land transport only likely to increase by 2012 and especially by 2030 as oil prices rise, the demand for quick reactions and substantial quality in the client sector (building and public works), the sizeable amount of investment required, and the necessary geographical limitations on relocations which exclude the cement works in Northern Europe from this process.

That is why the scenario of reducing CO_2 emissions, without accompanying policies and measures, seems to us to be plausible only with **a substantially lower negative impact on activity and employment in the European cement sector, of the order of 4% in 2012, and 15% in 2030. This would translate into less severe job cuts, involving some 2,100 jobs by 2012 and some 8,000 jobs by 2030.**

Alternative scenario n° 2, with accompanying policies and measures

Alternative scenario n° 2 features the **maintenance or even reinforcement of European cement production capacities and thus the number of jobs**, and the stabilisation of cement imports through a combination of factors supporting that process:

Concerning the structural evolution of the sector: curbs on relocations and imports become significant: higher cost of transport and energy in non-European countries, demand for faster reactions from European market.

Concerning the voluntarist P&M to accompany the cement sector to drive down its CO_2 emissions:

- P&M of a regulationist nature: CO_2 taxes on imports of non-European cement or normative adjustment mechanisms at borders of the same type as those we propose for the European iron and steel sector, mechanisms to manage the national and public markets for the construction of buildings and infrastructures by incorporating a carbon factor.
- P&M serving as incentives: the granting of fiscal aid, public funding and co-ordination of R&D programmes (Ulcos type), favouring the inexpensive introduction of new technologies, programmes to train workers on new products and processes in the industry.

This scenario is in line with the hypotheses of the works which anticipate no more than a slight drop (-1.2%) in European cement production for a hypothetical price of 15 euros/tonne of CO_2 [55].

The European cement manufacturers thus make the strategic choice to achieve the European Union objectives of reducing CO_2 emissions (-8% in 2012, -20% in 2020 and -30% in 2030) without reducing their European production capacities and by implementing the emission reduction actions advocated by the WBCSD, which offer the advantage of enacting only measures which are described as conventional and inexpensive.

However, the intensity of the public P&M necessary in support of the cement sector will be very different depending on the achievement of the objective threshold pursued of reducing CO_2 emissions. The threshold of 30% would seem to be crucial (according to the WBCSD and its expert partner, the American Batelle Institute), since a reduction of 30% in CO_2 emissions is possible by implementing conventional and inexpensive technologies and measures.

Beyond 2030: Factor 4 scenario in the European cement sector (-75% of emissions)

On the other hand, an objective of a reduction of more than 30%, of the factor 4 type, i.e. a reduction of 75% of emissions, will demand the implementation of an otherwise more ambitious R&D programme, involving technological breakthroughs, most particularly with regard to the procedures for new binders (currently being trialled and industrialised, see Chapter II).

This will need to mobilise substantial public-private funding, training programmes for managers and workers in the cement sector, as well as in its client sector (Building/Public Works), and sizeable mechanisms for scientific, technical and industrial co-operation, to adapt the enterprises concerned and their workers to cope with these new technological areas and these new organisational methods, but also regulatory P&M (norms for adjustment on borders).

[55] Smale, R., Hartley, M., Hepburn, C., Ward, J., Grubb, M., 2006. The impact of CO_2 emissions trading on firm profits and market prices. Climate Policy 6(1).

If these conditions are satisfied, the Factor 4 scenario will be able to be implemented while current employment volume is maintained

Without these voluntarist public P&M to provide accompaniment in terms of both regulation and support for the European cement sector, the cement groups would be implementing the same type of strategic decisions as in alternative scenario n° 1 on a larger scale, **which would generate an accentuation of a process of massive destruction of the order of some 20,000 jobs**, taking into account the obstacles to relocation which we have outlined above; strategic decisions which would then serve only to intensify the negative impact on employment generated by the current trend which is characterised by a structural process of relocation and increased imports.

Tableau III.39. : Employment evolution in cement sector in the European Union

Nombre d'ETP	1999	2000	2001	2002	2003	2004	2005	Δ 05/03 (en %)	Δ 05/99 (en %)
EU 15	48 179	46 960	46 401	45 087	44 483	42 642	41 889	-5,8%	-13,1%
EU 25					56 940	54 393	53 286	-6,4%	

Source : Cembureau

Tableau III.40. : Employment un the production sector of cement, lime and plaster in 17 countries of European Union

Pays	2002	2003	2004
Allemagne	12 342	12 549	8 535
Belgique		2 812	
Espagne	10 075	10 635	10 279
Finlande			842
France	6 500	6 481	5 945
Hongrie	2 195	1 827	1 717
Italie	11 889	11 909	12 344
Lituanie	765	743	745
Pologne	9 318		
Portugal	1 866	1 858	1 623
République tchèque	2 577		
Royaume-Uni	6 450	4 456	5 339
Slovaquie	2 552	2 573	2 678
Slovénie	974	909	620
Suède	761		846
Bulgarie	3 404	2 969	2 709
Roumanie	7 152	6 510	7 499

Source : Eurostat

Table III.41. : CO_2 Scenarios and employment of cement sector to 2012 and 2030

	Référence Kyoto		Scénario BAU		SCENARIO n° 1 (sans P&M d'accompagnement)			SCENARIO n° 2 (avec P&M d'accompagnement)		
	1990	2005	2010-12	2030	2012*	2030**	Post- 2030***	2012*	2030**	Post- 2030***
Émissions de CO2 de l'UE à 25 (en millions de tonnes)	166,8	168,0	171,1	175,5	153,5	116,8	41,7	153,5	116,8	41,7
Indice 100 en 1990	100	101	103	105	92	70	25	92	70	25
Nombre d'emplois ETP dans l'UE à 25		53 300	53 300	53 300	51 170	45 300	33 580	53 300	53 300	53 300
Emplois Indice 100 en 2005		100	100	100	96	85	63	100	100	100

Note : * - 8% par rapport à 1990 ** - 30% par rapport à 1990 *** - 75% par rapport à 1990

Tableau III.42. : CO_2 emission in the cement sector : 2010 et 2030 targets compared to BAU scenario and to the 1990 reference

	1990	2010 BAU	Objectif 2010	Objectif BAU 2010	Objectif 2010	Différence	Objectif facteur 4
	émissions de CO2 en millions de tonnes	émissions de CO2 en millions de tonnes	émissions de CO2 en millions de tonnes	Taux de variation par rapport à 1990	Taux de variation par rapport à 1990	2030 : - 30% par rapport à 1990	- 75% par rapport à 1990
Allemagne	23,2	26,3	26,1	-0,8%	12,5%	16,2	5,8
Autriche	3,5	2,9	2,8	-3,4%	-20,0%	2,5	0,9
Belgique	5,4	8,5	8,3	-2,4%	53,7%	3,8	1,4
Danemark	1,2	1,6	1,4	-12,5%	16,7%	0,8	0,3
Espagne	22,4	23,4	22,9	-2,1%	2,2%	15,7	5,6
Finlande	1,2	1,0	0,9	-10,0%	-25,0%	0,8	0,3
France	16,5	13,5	13,2	-2,2%	-20,0%	11,6	4,1
Royaume-Uni	10,5	10,8	10,7	-0,9%	1,9%	7,4	2,6
Grèce	9,8	9,4	9,2	-2,1%	-6,1%	6,9	2,5
Irlande	1,2	1,8	1,7	-5,6%	41,7%	0,8	0,3
Italie	30,8	29,5	28,9	-2,0%	-6,2%	21,6	7,7
Pays-Bas	2,7	2,7	2,4	-11,1%	-11,1%	1,9	0,7
Portugal	5,2	7,0	6,7	-4,3%	28,8%	3,6	1,3
Suède	1,8	2,0	1,8	-10,0%	0,0%	1,3	0,5
Union européenne à 15	**135,4**	**140,4**	**137,0**	**-2,4%**	**1,2%**	**94,8**	**33,9**
Chypre	0,8	1,3	1,3	0,0%	62,5%	0,6	0,2
Malte	0,0	0,0	0,0	0,0%	0,0%	0,0	0,0
Hongrie	3,2	3,6	3,6	0,0%	12,5%	2,2	0,8
Pologne	14,0	12,5	12,4	-0,8%	-11,4%	9,8	3,5
République tchèque	6,3	4,0	4,0	0,0%	-36,5%	4,4	1,6
Slovaquie	2,0	3,0	3,0	0,0%	50,0%	1,4	0,5
Slovénie	1,0	0,9	0,9	0,0%	-10,0%	0,7	0,3
Estonie	0,8	1,7	1,7	0,0%	112,5%	0,6	0,2
Lettonie	2,7	3,1	3,1	0,0%	14,8%	1,9	0,7
Lituanie	0,6	0,6	0,6	0,0%	0,0%	0,4	0,2
Union européenne à 25	**166,8**	**171,1**	**167,6**	**-2,0%**	**0,5%**	**116,8**	**41,7**
Roumanie	9,5	9,5	9,5	0,0%	0,0%	6,7	2,4
Bulgarie	3,9	4,7	4,7	0,0%	20,5%	2,7	1,0
Union européenne à 27	**180,2**	**185,3**	**181,8**	**-1,9%**	**0,9%**	**126,1**	**45,1**
Etats-Unis	63,0	80,0	77,6	-3,0%	23,2%	44,1	15,8
Japon	53,2	70,3	69,8	-0,7%	31,2%	37,2	13,3
Canada	10,2	10,5	10,1	-3,8%	-1,0%	7,1	2,6
Russie	65,5	58,6	58,6	0,0%	-10,5%	45,9	16,4
Ukraine	21,3	21,3	21,6	1,4%	1,4%	14,9	5,3

Tableau III.43. : CO_2 emission of the cement sector by produced ton by countries and region

Pays/Régions du monde	1990	2000
AMÉRIQUE DU NORD	**0,99**	**0,99**
Etats-Unis	0,99	0,99
Canada	0,94	0,91
EUROPE DE L'OUEST	**0,85**	**0,84**
EUROPE DE L'EST	**0,84**	**0,83**
ex-URSS	0,81	0,81
Autres pays d'Europe de l'Est	0,94	0,89
ASIE	**0,91**	**0,89**
Japon	0,73	0,73
Chine	0,95	0,90
Inde	0,98	0,93
Australie & Nouvelle-Zélande	0,80	0,79
Sud-Est asiatique	0,96	0,92
Corée du Sud	0,94	0,90
AMÉRIQUE LATINE	**0,86**	**0,82**
AFRIQUE	**0,87**	**0,85**
MOYEN-ORIENT	**0,87**	**0,85**
MOYENNE MONDIALE	0,89	0,87

Source : Batelle-CSI-WBCSD

Tableau III.44. : Utilization factor of alternative fuels* in the cement sector by country

Pays	**Taux de substitution**
Pays-Bas	83,0
Suisse	47,8
Autriche	46,0
Allemagne	42,0
Norvège	35,0
France	34,1
Belgique	30,0
Suède	29,0
République tchèque	24,0
Moyenne Union européenne	**12,0**
Japon	10,0
Etats-Unis	8,0
Australie	6,0
Royaume-Uni	6,0
Danemark	4,0
Hongrie	3,0
Finlande	3,0
Italie	2,1
Espagne	1,3
Pologne	1,0
Irlande	0,0
Portugal	0,0
Grèce	<1%

Source : Batelle-CSI-WBCSD
* Combustibles alternatifs exempts de CO2

Tableau III.45. : Potential of mitigation of CO_2 emissions by cement ton in 2020, by technical measure at the worlwide level

Champ d'action des réductions	Type d'actions	Réduction selon les régions	Taux de réduction
Emissions Process	Ciments mélangés	entre -1 et -35%	-7%
Emissions des combustibles	Efficience énergétique	entre -5 et -15%	-11%
	Combustibles alternatifs	entre -1 et -7%	-3%
Transport	Efficience énergétique et biocarburants pour le transport des combustibles et matériaux	< 1%	<1%
Production d'électricité	Production d'électricité plus efficiente et à bas carbone	< 1%	<1%
Compensation / substitution et autres réductions	AFR	entre -6 et -16%	-12%
Total de l'ensemble des actions *		**entre -30 et-50%**	**-30%**

Source : Batelle-CSI-WBCSD

* étant donné les interactions des actions, le total du potentiel de réduction des émissions n'est pas égale à la somme des effets des actions individuelles

Tableau III.46. : Energy intensity of the cement sector by produced ton of clinker by country and region of the world (in Mj by ton of clinker)

Pays / régions du monde	1990	2000
AMÉRIQUE DU NORD	**5,47**	**5,45**
Etats-Unis	5,50	5,50
Canada	5,20	4,95
EUROPE DE L'OUEST	**4,14**	**4,04**
EUROPE DE L'EST	**5,58**	**5,42**
ex-URSS	5,52	5,52
Autres pays d'Europe de l'Est	5,74	5,20
ASIE	**4,75**	**4,50**
Japon	3,10	3,10
Chine	5,20	4,71
Inde	5,20	4,71
Australie & Nouvelle-Zélande	4,28	4,08
Sud-Est Asiatique	5,14	4,65
Corée du Sud	4,47	4,05
AMÉRIQUE LATINE	**4,95**	**4,48**
AFRIQUE	**5,00**	**4,75**
MOYEN-ORIENT	**5,17**	**4,92**

Source : Batelle-CSI-WBCSD

6. The construction sector

6.1. Scenarios of CO_2 emission reduction in the European residential sector for 2012 and 2030

Emissions in the construction sector

In 2005, compared with other sectors, buildings represent 23% of CO_2 emissions (70% for the residential sector and 30% for the tertiary sector), or 46% of final energy consumption. Heating alone represents 2/3 of consumption and of CO_2 emissions.

Presentation of the 3 scenarios

The prospective evaluation of the effects on employment in the construction and housing sector makes use of the 3 following scenarios:

Reference scenario (Business As Usual, BAU)

This scenario supposes the application in the strict sense of the two existing European directives: The directive relating to energy performance of buildings[56] (EPBD) and the directive on the final uses of energy and energy services, adopted in December 2005.

The EPBD directive was to have been transposed into all Member States before 4 January 2006. The field of application of the directive is limited to new and existing buildings of more than 1,000m². This directive imposes minimum standards (fixed by the member countries) relating to the energy performance of new buildings as well as of existing buildings when they are subject to major renovation works and proposes a common method of calculation.

For new buildings of more than 1,000m², provides for a technical feasibility study for the incorporation of renewable energies to be carried out before the start of construction. It also requires a regular checking of boilers and central air-conditioning systems in buildings, as well as the evaluation of a heating installation when it includes boilers more than 15 years old.

The directive on the final uses of energies is to be transposed by Member States on 17 May 2008 at the latest. It requires that Member States realise energy savings of 1% per year over a period of nine years, or 9% between 2008 and 2017. It obliges the public sector to choose 2 measures out of 6 specified to achieve this objective, one of them consisting of buying or renting energy-efficient buildings.

This scenario leads to a reduction of 34 million tonnes of CO_2 a year at the 2010-2012 horizon, or a reduction of 8% **compared with when?**

Eurima alternative scenario

This scenario, developed by the ***European Insulation Manufacturers' Association (Eurima)***, supposes a revision of the European directive EPBD extending it field of applicability to all dwellings in the European Union, including the small dwellings of disadvantaged families. In the 10 new Member States, the objective is to reduce energy intensity so as to achieve in 10 years the level of 94 Kwh/m² for individual houses and 66 Kwh/m² for collective dwellings.

This scenario leads to a reduction of 70 million tonnes of CO_2 a year in the residential sector, or 16%.

"Factor 4" alternative scenario

The objective is a reduction of 75% in CO_2 emissions in the residential sector in the long term (2030 or 2050). On the average, dwellings in Europe consume 250 Kwh/m², 200 of which is thermal in origin (heating and hot water). To achieve the factor 4, it is therefore necessary to go from 250 Kwh/m² to 60 Kwh/m², and thus diminish the thermal consumption by ¾, going from 200 to 50 Kwh/m².

To achieve this factor 4 objective in the residential sector, thermal improvement of the whole of the existing housing stock, which

[56] 2002/91/EC

requires massive investment, is indispensable, as new construction each year represents a tiny part of the existing stock.

Today, 11% of households in Europe invest in renovation works to reduce the energy consumption of their homes for an amount of 3,000 euros per dwelling (or on average 34 euros/m^2). To achieve factor 4 in the residential sector, an average investment of 204 euros/m^2 (in constant 2006 euros) is necessary, knowing that the room to manoeuvre is greatest in thermal insulation works in dwellings of small area (source Cheuvreux), with technology existing in 2006. New technology in energy equipment and materials could in the medium and long term more or less appreciably reduce the amount of investment necessary.

Two variants of the "Factor 4" scenario are studied. One corresponds to the implementation of the thermal improvement program with a horizon of 2050. The other assumes an accelerated implementation, with a horizon of 2030.

The policies and measures corresponding to the 3 scenarios

These three scenarios will demand policies and measures (P&Ms) at the national and European levels targeted at energy efficiency and the reduction of CO2 emissions from the residential sector:

- Regulatory P&Ms: standards, procedures (energy and carbon accounting), taxes;
- P&Ms in the form of incentives: fiscal measures (tax deductions, tax credits, at national and local levels), financing facilities for thermal upgrading investments (long-term loans at preferential or zero rates granted by banking systems and public institutions), energy certificates, creation of reference frames (seals of approval such as HQE, Breeam, etc.)
- P&Ms to promote research and development activities in the building industry and the building supply and materials industries.
- P&Ms for the development of training streams for new skills and new occupations of the players in the "sustainable construction" branch, to adapt supply to the requirements of the new residential sector market.

For details about the P&Ms, see the part of the report relating to "energy efficiency and employment".

6.2. The effect on employment of the various scenarios

Method

The estimations of the three scenarios relate to direct "full-time equivalent" (FTE) jobs in the construction sector. These direct jobs include all thermal insulation and energy-efficiency works, i.e. installation works but also activities of design production and maintenance of low-energy-consumption heating and ventilation equipment, thermal regulation and energy-saving services. Not included are jobs linked to lighting equipment, or those linked to the design, production and maintenance of household appliances and equipment.

Indirect jobs are not evaluated, even though we shall present, as food for thought, some elements of job evaluation according to the method defined by a British study by the ACE association.

BAU scenario

More than three quarters (78%) of the heat consumption of residential and tertiary-sector buildings involves occupied areas less than 200m^2 (source Eurima), which are exempted from the application of the European directive of 2002 on the energy performance of buildings. The BAU scenario therefore takes into account this situation which limits its application to 22% of the heat consumption of the European building stock.

The effects on employment in the countries of the EU-15

Currently, in the EU-15, the construction sector has a turnover of 910 billion euros in 2004, corresponding to 11.7 million FTE jobs (source FIEC), or 78,000 euros of turnover per year per FTE job.

The strict application of the European directive makes it necessary to invest a further 10 billion per year in the residential sector in the EU-15 (or 1.1% of the turnover of the sector).

Assuming a range of 160,000 to 500,000 euros/year/FTE job needed for the full effect of the directive, this scenario results in the creation of 20,000 to 62,500 additional FTE jobs (Ecofys-Eurima method of calculation). This range will vary according to the type of materials and equipment used.

The effects on employment in the 10 new Member States

In 2005, in the 10 new Member States, the construction sector had a turnover of 45 billion euros, corresponding to 1.5 million FTE jobs (source Eurostat).

The application of the directive makes it necessary to invest an amount of 1.6 billion/year in the energy efficiency of the residential sector in the 10 new Member States. Assuming 35,000 euros/year/FTE job, the BAU scenario leads to the creation of an average of 45,000 new FTE jobs per year (Ecofys-Eurima method of calculation).

Eurima alternative scenario

The effects on employment in the countries of the EU-15

The investments required amount to 25 billion euros per year (or 2.8% of the 2004 turnover of the sector), or a level of investment 2.5 times greater than in the BAU scenario. The reduction in energy costs obtained is 8 billion euros, or close to a third of the amount invested.

Assuming a range of 160,000 to 500,000 euros/year/FTE job, this scenario results in the creation of 50,000 to 150,500 additional FTE jobs (Ecofys-Eurima method of calculation).

The effects on employment in the new Member States of the EU-25

The investments required amount to 4.7 billion euros per year (10.5% of the turnover of the sector), which will generate 135,000 new jobs (assumption: 35,000 euros/year/FTE job).

However, if the urgent needs for dwelling renovations were satisfied by additional energy-efficiency investments of 3.5 billion euros per year, these would only lead to the creation of 20,000 to 50,000 additional FTE jobs, because these additional investments would necessitate the incorporation of new materials.

"Factor 4" alternative scenario

Extrapolating the figures provided by Ademe, as well as Eurostat, Cheuvreux and European Property Federation, we estimate that the European market (for a sample of 16 European Union countries) for insulation and the installation of low-energy-consumption heating equipment (incorporating renewable energies) in the residential sector should reach 3,145 billion euros overall (see attached table).

The implementation of a programme like this translates to 73 billion euros annually in investments (that is, 7 times more than the amount of investment induced by the application of the 2002 directive), if this programme is spread out over a period from 2006 to 2050 or to 137 billion euros a year, if the programme is spread between 2006 and 2030 (that is, 14 times more than the amount of investment induced by the application of the 2002 directive).

Other things being equal, in particular in relation to public policies and measures, two thirds of this amount will have to be borne by households. But this will certainly make it necessary that all players concerned reconsider the conditions of support for households (but also for workers in the construction sector) to assure the implementation and effectiveness of these investments.

Implementation over the period 2006-2050

If one accepts the European hypotheses of the "Factor 4" scenario (53,000 euros/year/FTE job), the new jobs generated in the "Factor 4" scenario in 2050 will be 1,377,000 FTE.

If one accepts the job hypotheses of Eurima and Ecofys, the number of new jobs generated annually would lie in a range between 146,000 and 456,250 FTE.

For Poland and Hungary, the new jobs generated would amount to 117,000 and 48,600 FTE respectively on the hypothesis of 35,000 euros/year/FTE.

Accelerated implementation 2006-2030

In this variant the European construction sector will have to mobilise significantly more human resources.

With the "Factor 4" scenario hypothesis of 53,000 euros/year/FTE job, new jobs would amount to 2,585,000 FTE per year.

If one accepts the job hypothesis of Eurima and Ecofys, the number of new jobs generated annually would lie in a range between 274,000 and 856,250 FTE.

For Poland and Hungary, the new jobs generated would amount to 214,300 and 91,430 FTE respectively on the hypothesis of 35,000 euros/year/FTE.

For the 11 countries in the study sample, employment in the construction sector represents a substantial weight in the national economy: in total, in 2003, this sector employed more than 10 million workers with contrasting movements since 2002 depending on the country.

Table III.47.: Residential "Factor 4" scenario: Estimation of the European market for the renovation of dwellings to achieve energy and CO_2 emissions savings to the level of 50 Kwh/m²

PAYS	Emissions 2002 de CO2 dans les logements million tonnes	Emissions 2002 de CO2 par habitant dans les logements	Surface moyenne des logements m2 2005	Consommation moyenne des m˜nages (10 9 KWh) 2005	Nombre total de m2 de logement ('000) 2005	Consommation par logement KWh/m2 2005	Consommation thermique par logement KWh/m2 2005	Co¸t des travaux pour atteindre un objectif de 50 KWh/m2 (EUR05)	Inv de (Bill
Autriche	11,3	1,4	90	88,7	307 260	289	231	307,6	
Belgique	14,3	1,4	86	115,2	374 358	308	246	333,5	
Danemark	4,6	0,8	109	50,3	270 429	186	149	167,7	
Finlande	8,5	1,6	76	59,8	182 400	328	262	360,7	
France	64,7	1,1	88	478,7	2 237 928	214	171	205,9	
Allemagne	52,0	0,6	86	884,3	3 323 040	266	213	276,9	
Hongrie	nc	nc	85	77,8	351 560	221	177	215,9	
Irlande	1,9	0,5	88	31,5	121 880	259	207	267,0	
Italie	86,0	1,5	90	348,3	2 097 990	166	133	140,8	
Pays-Bas	14,6	0,9	98	120,7	695 408	174	139	151,1	
Pologne	39,0	1,0	85	204,1	1 149 625	178	142	156,4	
Portugal	7,5	0,8	83	36,2	316 728	114	91	70,4	
Slovaquie	4,9	1,0	85	32,7	163 200	200	160	187,1	
Espagne	71,3	1,8	85	156,5	1 327 190	118	94	75,4	
Su¸de	6,6	0,7	89	86,5	384 925	225	180	220,6	
Royaume-Uni	49,4	0,8	85	506,2	2 142 680	236	189	236,3	
TOTAL 16 Pays de l'UE					**15 446 601**		**200**	**203,6**	

Extrapolations des donn˜es de l'Ademe, Eurostat, Cheuvreux, European Property Federation

* Including all thermal insulation works (including design, production and maintenance of low-energy-consumption heating and ventilation equipment, as well as energy-saving services). Not included are lighting equipment, or the design, production and maintenance of household appliances and equipment.

Method of calculation for estimation of the annual creation of jobs in the "Factor 4" scenario for the residential sector by country and by year:

= (Investments required per m²/year X Number of m² housing stock of country) / Mean ratio: amount of investment needed in euros/1 FTE job

Effect on employment by member state for the "Factor 4" scenario

To start with, we may observe that the dwelling renovation investments required to achieve the factor 4 objective of 50 Kwh/m² are very different depending on the EU country, because of both the initial thermal conditions of the dwellings, household behaviour, innovative solutions applied and economic factors specific to each country.

The costs of the necessary works would be highest in Finland (361 euros/m²) and in Belgium (333 euros/m²), which is related to the high energy intensity of dwellings in these countries.

On the contrary, the costs of the necessary works will be 4 times less in countries like Spain (75 euros/m²) or Portugal (70 euros/m²). However, in Italy, these costs will be as good as 2 times higher than in Spain.

The countries situated above the mean for costs of works needed per m² to achieve the factor-4 objective are: Germany (277 euros/m²), Ireland (267 euros/m²), the United Kingdom (236 euros/m²), France (206 euros/m²).

Obviously, the employment generated by dwelling renovation activity required to meet the factor-4 challenge will be all the more substantial for the energy and carbon accounts of the housing stock being in deficit.

We shall present an evaluation of this impact on employment for a sample of countries for which the housing stock in area (m²) represents 12.7 billion m², or ¾ of the housing stock of the European Union of 25: Germany (which possesses the biggest housing stock in Europe with 3.3 billion m²), in front of 3 countries with the same existing area of housing, France (2.2 billion m²), the United Kingdom (2.14 billion m²) and Italy (2.10 billion m²), then Spain (1.3 billion m²), Poland (1.1 billion m²), Belgium (0.4 billion m²) and Finland (0.2 billion m²).

Table III.48. : Evolution of employment in the construction sector in 11 EU countries

	Allemagne			Royaume-Uni			Italie			France			Espagne			Pologne		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
Emploi dans la construction, dont	1 824 337	1 697 818	1 568 766	1 307 461	1 322 639	1 347 408	1 574 979	1 705 742	1 728 804	1 470 596	1 494 723	1 306 055	2 189 274	2 310 522	nc	686 791	626 057	613 799
onstruction d'ouvrages de bâtiment			726 657			742 877			1 022 304			581 458						398 815
Travaux d'installation			452 325			339 028			482 886			320 676						141 828
Travaux de finition			348 332			226 763			176 895			324 603						57 839

	Finlande			Belgique			Tchéquie			Hongrie			Slovénie			Total		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002*	2003**	2004***
Emploi dans Construction, dont :	122 321	123 790	125 976	nc	249 742	nc	393 643	391 447	370 412	240 748	232 348	233 802	65 588	63 780	63 728	9 875 738	########	7 358 750
onstruction d'ouvrages de bâtiment			69 669						241 810			127 991			39 945			3 951 526
Travaux d'installation			31 445						61 776			61 002			10 798			1 901 764
Travaux de finition			11 561						42 545			32 836			10 500			1 231 874

Note : * dix pays ** onze pays *** neuf pays

Emplois ETP créés annuellement par le scénario Facteur 4 dans le secteur résidentiel dans 10 pays de l'Union européenne en fonction du rythme de mise en œuvre du programme d'investissements nécessaire

	Allemagne	France	Royaume-Uni	Italie	Espagne	Belgique	Pologne	Finlande	Hongrie
Investissements Facteur 4 Logement (en Md€)	920	461	506	296	100	125	179	66	76
Investissement au m2 (en euro)	277	206	236	141	75	334	156	361	216
Investissements annuels horizon 2030 (milliards d'euros)	38,3	19,2	21,1	12,3	4,2	5,2	7,5	2,8	3,2
Investissements annuels horizon 2050 (milliards d'euros)	20,9	10,5	11,5	6,7	2,3	2,8	4,1	1,5	1,7
Emplois directs ETP créés annuellement, à l'horizon 2030									
Méthode de calcul GT France Facteur 4	722 642	362 420	398 113	232 076	79 245	98 113	141 510	52 830	59 755
Méthode de calcul Ecofys-Eurima :									
Minima de la fourchette	76 600	38 400	42 200	24 600	8 400	10 400		5 600	
Maxima de la fourchette	239 370	120 000	131 875	76 875	26 250	32 500		17 500	
Emplois directs ETP créés annuellement, à l'horizon 2050									
Méthode de calcul GT France Facteur 4	394 340	197 680	216 980	126 415	43 396	52 830	77 358	28 302	32 075
Méthode de calcul Ecofys-Eurima :									
Minima de la fourchette	41 800	20 950	23 000	13 400	4 600	5 800		3 000	
Maxima de la fourchette	130 625	65 480	71 875	41 875	14 375	17 500		9 375	

Case analysis: Germany

The "Alliance for Work and Environment" at work since 2001

The case of Germany holds a lot of lessons on the question of employment generated by investments in thermal renovation of dwellings, through the experience of an ambitious programme launched in 2001 by the "Alliance for Work and Environment" (*Allianz für Arbeit und Umwelt*).

This alliance, created in late 2000 on the initiative of the DGB and its affiliated unions, brings together, apart from workers' unions, the German federal government, the relevant employers' federations (construction, insulation materials, heating and air-conditioning equipment and installations, architects…).

Table III.49. : German programme « Alliance for jobs and environment » : volume of annual investissements and additional job creation in construction sector

M	2001	2002	2003	2004	2005	2006
Invt public funding	200	200	360	360	600	2 100
Led private invt	800	800	1440	1 440	2 400	8 400
Total invt	1 000	1 000	1 800	1 800	3 000	10 500
ratio invt euro / ETP / year	92 600	42 430	70 000	72 000	72 000	72 000
additional jobs created FTE/Year	10 797	23 569	25 765	24 783	41 670	145 800

There are several objectives:

- To renovate 300,000 dwellings per year
- To create 200,000 jobs both in the construction sector and also in the design and production of equipment contributing to environmental protection, research and consulting.
- To reduce CO_2 emissions by 2 million tonnes per year (or 4% of annual emissions from dwellings in Germany).
- To reduce energy bills for tenants and owners
- To allow the state to save 4 billion euros linked to the reduction in unemployment and the increase of tax receipts and social security contributions.

The means allocated to this programme

Since 2001, a fund of 1 billion euros of public subsidies has allowed a volume of private investments of about 5 billion euros to be mobilised. Between 2003 and 2005, the federal government made an additional 160 million euros available to the Alliance, leading to a doubling in the volume of investments. (see table opposite).

The CDU-SPD government agreement of 11 November 2005 decided to increase this programme by 1.5 billion euros a year.

The mechanism

Granting credits at preferential rates to owners, tenants or housing associations who submit thermal renovation projects to the Alliance (insulation, heating and renewable energy systems…) along with information about the associated potential for reduction in energy consumption. Projects are selected by priority on the basis of criteria of improvement of energy efficiency and reduction of CO_2 emissions.

Results

In 2004, the German government evaluated:

- the effective application of the programme at 200,000 dwellings,
- the reduction of CO_2 emissions at 1 million tonnes (or 2% of annual emissions from dwellings in Germany).
- the annual creation of **additional** FTE jobs at only 25,000.

Several factors may have intervened to explain this gap in relation to job creation linked to this programme:

- The severity of the recession in the construction sector in Germany for the previous decade: between 2002 and 2004, the number of jobs in this sector was thus reduced by another 255,000 workers (see table); which explains that, apart from the

25,000 additional jobs created, a large number of jobs (estimated at 116,000 between 2002 and 2004) were simply saved because of this programme.

- The substantial productivity gains made in the construction sector, not just because of a process of rationalisation carried out in the sector, but also resulting from a process of optimisation of the installation of thermal insulation equipment and materials carried out upstream by equipment and materials manufacturers in the design of their products.

Energy saving fund project

The energy saving fund project EnergySavingFund (12 programmes spread out between 2006 and 2030), conceived in Germany, which would involve several highly energy-intensive sectors (manufacturing, tertiary, public administration, housing), through 12 programmes spread out between 2006 and 2030, should, according to the Wuppertal Institute's study for the Hans Boeckler Foundation (see national report on Germany), allow:

- an energy saving of 10% (or 75 billion KWh of electricity consumption and 102 billion KWh of heating) of the primary energy consumption of final users, or a monetary saving of 9 billion euros.
- The creation to this end of 41,700 FTE jobs on average per year (of which 12,500 FTE would be tradesmen working essentially in construction) with a maximum of 75,000 FTE jobs in 2015.

6.3. *Winners and losers from the energy-efficiency policies and measures in the residential sector*

Intensity of the work factor

The number of jobs generated by investments in energy efficiency in the tertiary-residential sector is greater than of those created in the electricity generation sector, which is highly capitalistic and has a low labour-intensity, both direct jobs (construction sector and the construction materials and thermal equipment manufacturing industries) and indirect jobs (everyday consumer goods sector) generated by household energy-bill savings.

Investment in energy efficiency in the residential sector creates jobs in larger numbers than in the other sectors.

The direct jobs created

Jobs have been created :

- In production and distribution of insulating building materials (double glazing, glass wool…), energy-saving equipment (low-temperature or condensing boilers, heat-regulating devices, renewable-energy heat-producing devices and systems).
- In large and small businesses in the construction sector for the construction, installation and maintenance of the materials and equipment required for the energy efficiency of housing. Large enterprises are better placed for new construction, while small businesses are dependent on big businesses for new construction but independent on the market for renovation of existing housing stock. There seems to be a lack of motivation and preparation of businesses in the construction sector to take up the challenge of "Factor 4" in the existing residential sector, whereas they are more motivated financially by the "high environmental quality" (HEQ) process in new construction.
- In activities of management, administration and control of energy-efficiency investment programmes. These are provided by public agencies, public or private energy enterprises, or a combination of these players.
- In the service activities to optimise energy savings: advice, energy audit, marketing.

A maximum number of jobs has been created in the first two categories, i.e. manual activities.

In the United Kingdom, these manual jobs have been created in very diverse areas, but primarily in areas where the dwellings were occupied by socially disadvantaged populations and where the rate of long-term unemployment was highest, which has necessitated training programmes for these unemployed people so they can fill the jobs created.

The direct jobs created for new construction (generally the major building companies) and renovation of existing buildings (generally small building companies dispersed in local economies) are characterised not being able to be delocalised.

The indirect jobs created

These jobs have been the subject of many studies in the United Kingdom through the estimation of the multiplier effect of energy efficiency investment.

The British Department for Education and Employment (DFEE) had estimated in 1996 that this type of investment had a positive effect on employment at the level of the local economy, of the order of 17 indirect jobs for 100 new direct jobs created.

The major impact of energy-efficiency investment on indirect employment is not due solely to the effect of the additional purchasing power induced by the creation of direct jobs, but also the additional purchasing power for everyday consumer goods released by the reductions in household energy bills.

But this will depend on the amount of the investment, how it is financed, its return time, and the initial thermal comfort situation of these dwellings.

These indirect jobs may be spread over several years after the creation of direct jobs linked to the construction or renovation works.

Job losses in the energy production sector

Job losses in the energy production sector (electricity, fuel, gas, coal) may be brought about by energy savings achieved in the residential or tertiary sectors, but they will be limited given the highly capitalistic and non-labour-intensive nature of the energy-production sector.

Professionals (builders, installers, construction material and thermal equipment manufacturers…) are putting up resistance to the change towards the development of sustainable buildings.

6.4. Lessons of the ACE (SAVE) study: effect on employment of energy-efficiency policies and measures in the residential sector

Aim and methodology of the ACE study

This study, conducted in 2000 by the British Association for the Conservation of Energy (ACE) in partnership with 9 national institutes and research centres of the European Union, was financed by the European Commission (DG TREN, Programme SAVE).

The objective of this study was to supply political decision-makers with tools to evaluate the local and national impacts on employment of energy-efficiency investments by sector (residential, tertiary, manufacturing, public administration) and by type of public policies and measures, over the period 2000-2010, starting from energy-efficiency investment programmes launched in 1995.

The P&Ms taken into account include fiscal incentives and assistance, regulation, information, awareness and education-training campaigns for consumer households as well as for decision-makers and workers.

It proceeded by the analysis of 44 case studies (of which 20 relating to the residential sector) in 9 countries (Germany, the United Kingdom, France, Spain, Finland, Austria, the Netherlands, Ireland, Greece); this approach was complemented by an evaluation of direct jobs at the national level by an input-output model and at the European level by a general equilibrium model.

Table III.50. : ACE study : evaluation of employment impact of energy efficiency P&M per type of P&M and per sector (residential/ tertiary/ industrial, average from 44 national case studies)

Type de Politiques & Mesures	Total des investissements (en M€)	Investissement moyen par an (en M€)	Contribution de l'Etat (en %)	Payback (en nombre d'années)	Montant de l'investissement par emploi ETP créé (en K€)	Emplois ETP par million d'euros investi	Emplois ETP par million d'euros investi par l'Etat
P&M Fiscales							
Secteur Résidentiel	8,2	8,0	77,0	18,0	13,5	74,1	22,5
Secteur Tertiaire (commercial, administration publique)	14,6	6,7	13,0	12,3	9,0	111,1	49,8
Secteur industriel	18,5	9,3	14,0	6,6	3,8	263,2	21,1
P&M Réglementaires							
Résidentiel	2 030,0	119,2	0,5	24,5	11,3	88,5	2 260,0
P&M Information/Education/Formation							
Secteur Résidentiel	4,8	1,6	8,0	39,0	14,0	71,4	940,0
Secteur Tertiaire (commercial, administration publique)	9,8	5,5	10,0	2,6	8,6	116,3	86,0
Secteur industriel	5,3	1,4	12,0	2,6	11,8	84,5	100,0
Autres P&M							
Maitrise demande d'énergie des producteurs d'énergie	7,8	6,0	8,0	5,6	8,8	113,6	120,0
Programmes institutionnels	6,6	1,7	15,0	5,5	13,0	76,9	86,7

Emplois directs inclus
Source : ACE

Table III.51. : ACE study: Evaluation of employment impact of national fiscal P&M per type of P&M in the residential sector from modelisation exercise

	Total des investissements (en M€)	Investissements annuels (en M€)	Contribution de l'Etat (en %)	Montant annuel des investissements par emploi ETP créé (en K€)	Emplois ETP par million d'euros investi annuellement	Emplois directs par million d'euros investi annuellement	Emplois indirects par million d'euros investi annuellement	Emplois ETP / an par million d'euros investi par l'Etat
HEES (1991-1996)	412,0	68,7	100%	107,2	9,3	4,6	4,7	9,3
Heatwise (1996)	3,0	3,0	100%	70,4	14,2	14,2	0,0	14,2
Standard of Performance (1994-1998)	125,0	25,0	0%	108,7	9,2	2,5	6,7	pas de dépenses publiques
Building Regulations (1996-1997)	76,0	38,0	nd	44,1	22,7	17,3	5,4	nd

Source : ACE

Both direct and indirect effects on employment were quantified at the same time.

- The direct effects were those linked to activities of production, installation and use of energy-efficiency products and procedures and in the management of the promotion programme for these investments.
- The indirect impacts were those linked to the change in the spending structure of the beneficiaries of the reduction of energy bills towards supplier sectors (everyday consumer goods and consumer durables) whose labour content is higher than that of the energy production and distribution sector.

Analysis of policies and measures and their effect on employment

The job gains produced by energy-efficiency actions in the residential sector are greater than those observed in the other sectors. Nevertheless, energy-efficiency investments in the residential sector are more costly given the quicker return of investment obtained in the other sectors (manufacturing, tertiary, public administration). This return of investment in the residential sector varies between 18 and 39 years according to the policies and measures.

Even if employment is not the major motivation for decision-making and public P&Ms in the area of energy efficiency in the residential sector, the effects on employment are significant, given that the construction and renewable-energy thermal equipment sectors are labour-intensive, with non-delocalisable jobs that are inserted in the local and regional fabric. The ACE study finds that in these local economies, the needs for appropriate training are substantial both for workers and for managers.

Without voluntary public policies and measures, the job opportunities represented by energy-efficiency investments in the residential sector will not take off, especially since other handicaps weigh down this sector (insufficient household budgets, poorly-motivated banking sector).

For each million euros of (public and private) investments in energy-efficiency programmes in the residential sector, the number of additional jobs created varies on average between 11.3 FTE (88,495 euros/FTE job/year) and 13.5 FTE (74,074 euros/FTE job/year), according to the type of P&Ms carried out: fiscal, normative-regulatory, informative-educational-training, R&D-promoting.

Fiscal P&Ms in terms of energy efficiency create more jobs in the residential sector than in the other sectors (manufacturing, tertiary, public administration).

But overall, in terms of energy-efficiency investments in the residential sector, it is information/awareness-raising/training actions that are considered to be best at creating jobs: 14 FTE per million euros as against 13.5 FTE for fiscal P&Ms and 13.0 FTE for institutional R&D programs. Nevertheless, they are considered as having a less certain effect on employment than the other public actions.

Compared with the amount of public investment, job creation linked to fiscal P&Ms is less than for normative and regulatory P&Ms or for information-awareness P&Ms which require negligible public expenditure by comparison.

The net impact of fiscal P&Ms is varies greatly according to the country (cf table below): net job gains were found for projects in France and the United Kingdom (respectively 12.9 FTE net and 14.2 FTE net per million euros invested) but a net loss in Germany (9.5 FTE per million euros invested) in the framework of the German KfW CO_2 reduction programme, the direct jobs created in the building and material and equipment manufacturing sectors not having made up for the loss of jobs in energy production and the everyday consumer goods sectors not having benefited from the increased purchasing power generated by the potential energy savings.

The impact on employment of regulatory P&Ms is more significant when they apply to existing buildings compared with new construction.

Energy-efficiency programs in the residential sectors are more job-creating and less costly when they are conducted at the regional level than at the national governmental level.

Evaluation of the effects on employment of each type of P&Ms in favour of residential energy efficiency, on qualitative aspects.

The lifetime of energy-efficiency investment programmes in the residential sector varies between 1 and 10 years on average. The jobs created are generally of a duration equivalent to that of the programme, except in the United Kingdom where the duration of work contracts may vary according to the uncertainties and vicissitudes of the financing of these programmes.

The employment contracts are generally of temporary duration but numerous programmes are implemented for a sufficiently long time to consider these contracts as *de facto* permanent.

Many national residential energy-efficiency systems have the objective of stimulating the market for thermal renovations of dwellings in the long term to ensure a permanent capitalisation of the know-how in production, installation and maintenance.

It is estimated that 50 to 90% of the new jobs created were in manual functions like delivery and installation of materials and equipment, the remainder being involved with functions of management, administration, advice-audit and R&D.

The level of annual salaries of the jobs created in the 9 countries studied lies in a range going from 22,000 to 45,000 euros. The share of salaries in the expenses of energy-efficiency programmes varies appreciably, from 12% to 76%.

The Input-Output model has estimated the distinctive effects of the impacts of P&Ms on employment between short and long term, direct and indirect.

Overall, P&Ms intended for the residential sector induce a high level of direct employment. The employment created is all the more desirable for its being geographically dispersed (in contrast with jobs in energy production) and for its being able to mobilise small local businesses. However, investments had a high cost in numerous cases studied.

The Input-Output model demonstrates that the redistribution of financial resources saved by reductions in household energy bills is a substantial source of non-delocalisable net job gains, especially in small businesses on a local scale.

The direct jobs created are relatively low-skilled but are not unskilled for all that and residential energy-efficiency programmes require significant and appropriate training programmes without which the investment programmes and the P&Ms would be ineffective.

The contribution of energy efficiency to the reduction of energy poverty and social insertion: the HEES and HEATWISE programmes in the United Kingdom

The objectives of the programmes

The objective of the government energy-efficiency programmes in the residential sector in the United Kingdom was above all to reduce the financial difficulties of several million households whose modest budgets are amputated by the onerous energy bills due to the low energy efficiency of dwellings (“fuel poverty”).

The objective, then, is not job creation. But the investments in energy efficiency created jobs and had to include training to increase the skill levels necessary to perform the work demanded, to that the extent that many manual jobs were created in areas of high levels of long-term unemployment.

The investments made

The HEES (Home Energy Efficiency Schemes) programme, launched in 1991 and renewed in 2000, received 412 million euros over 6 years between 1991 and 1996. The whole cost of energy-efficiency improvements is subsidised. The average amount of the public subsidy per household is estimated at about £600. In the end it produced annual energy savings estimated at 720 GWh, or around 25 million euros, and a recoupment of investment in 17 years.

The Heatwise project was implemented between 1983 and 1996, essentially in Glasgow. It was centred both on thermal insulation works to disadvantaged families' old dwellings, energy audit services and information, exchange of experience, and training campaigns on energy efficiency, aimed not only at the workers concerned but also at resident households, school children, students and teachers. In 1996, the project took the material form of the performance of external insulation works on 186 dwellings and the internal insulation of 37 lofts, ventilation works on 2,347 houses, and energy service provision (diagnostic, advice) involving 2,900 visits.

Direct job creation

These programmes demonstrate that an energy-efficiency investment program in the residential sector is an opportunity to develop jobs (temporary creations for the duration of the works), skills and skills training for the long-term unemployed in socially disadvantaged residential areas.

Over the period 1991-1996, the HEES programme created 640 jobs/year (750 FTE in 1996, or 9.3 FTE per million euros invested), but in 1997, a big reduction in the programme's budget (-30%) caused numerous job losses resulting from the failure of construction companies accredited by HEES, 50-75% of whose activity depended on this public programme, but also resulting from economic difficulties encountered by manufacturing companies producing insulating materials and thermal equipment.

Over the period 1991-1996, 2,000 workers were able to benefit from skills training as part of this investment programme.

The employment balance sheet of the HEATWISE project is drawn up like this: 84 people had an FTE job for one year over the years 1995 and 1996 through hiring for one year of long-term unemployed people after training in the framework of the HEATWISE project by an ad-hoc group of trainers, so we see the creation of 42 FTE jobs per year; at the same time, 194 people were trained during these two years.

Since the beginning of the HEATWISE project, 2,000 deskilled people in long-term unemployment have been able to be trained and increase their employability considerably.

Two thirds of them were able, after benefiting from the Heatwise programme, to get a job, and half of them a lasting permanent job; thanks to both the training acquired and the experience gained during the year of the Heatwise contract. Indirect job creation

Table III.52. : Energy efficiency programme in the residential sector in the UK (1990s) and impact on direct and indirect employment (private investment included)
from ACE study data

Nature du Programme	TOTAL Investissements en millions d'euros	Investissements annuels en millions d'euros	Contribution de l'État en %	Montant annuel Investissements par emploi ETP créé (en Keuros)	Emplois ETP par million d'euro investi annuellement	Emplois directs par million d'euro investis annuellement ETP/an	Emplois indirects par million d'euro investis annuellement ETP/an	Emplois ETP/an par million d'euro investis par l'État
HEES (1991-1996)	412,0	68,7	100%	107,2	9,3	4,6	4,7	9,3
HEATWISE (1996)	3,0	3,0	100%	70,4	14,2	14,2	0,0	14,2
SOP (1994-98) (Standard Of Performance)	125,0	25,0	0%	108,7	9,2	2,5	6,7	pas de Dépenses publiques
BUILDING REGULATIONS (1996-97)	76,0	38,0	nd	44,1	22,7	17,3	5,4	nd

Source : ACE

A common point of these two programmes is that 50% to 100% of the improvement in energy efficiency was not used by households to increase their expenditure on everyday consumer goods but simply to increase the temperature of their dwelling.

Because of this, indirect jobs created were negligible.

Summing up, these projects had more substantial social efficiency (better thermal comfort for households, job creation, skills training and better social insertion) than their energy efficiency. They may however be an effective measure to reduce CO_2 emissions in the long term if the financial resources released are adequate.

6.5. Need to develop an R&D strategy mobilising all players in the building branch and creating highly-skilled jobs

R&D applied to construction materials and heating and ventilation equipment from renewable sources will be an important issue towards improving not only the energy performance but also the economic and financial performance of energy-efficiency investments.

Generally speaking, R&D for energy efficiency of buildings is weak and badly exploited in Europe, and does little or nothing to motivate players in the building branch, whereas there is enormous potential in this sector.

The technology is already able to respond to environmental and energy-efficiency issues directly concerning the construction sector. But innovations have a very hard job establishing themselves, whether they be in building and insulation materials and heating equipment, or in the introduction of renewable energies, because resistance to change is strong in this sector.

The construction sector is characterised by the predominance of small businesses not generally having invested in R&D and who are slow to acquire new technical knowledge.

It is therefore necessary that public authorities support environmental and energy-related R&D and the spread of technologies in the whole of the construction sector.

By establishing a close partnership with the enterprise associations in the sector, it would be possible to apply more effectively the public programmes supporting R&D and the diffusion of new environmental technologies and to thus achieve a greater number of geographically dispersed enterprises in the sector.

Many governments in Europe, and more especially in France, the United Kingdom and Germany, have become aware of this weakness in innovation of this sector and hope to realise building estates with a nil primary energy balance or zero CO_2 emissions which could serve as a showcase, even buildings with a positive energy balance. This demonstration of the current potential of science would allow the preparation and support for the necessary technological breakthrough to be undertaken on a large scale in both new and existing buildings to achieve the "Factor 4" objectives before 2050.

Thus in France the state had to set in motion an R&D programme entitled "PREBAT" (*Programme national de recherche et d'expérimentation sur l'énergie dans les bâtiments*=National Programme of Research and Experimentation into Energy in Buildings) provided for by the "Plan climat France" for a duration of 5 years (2005-2010), valued at 20 million euros in 2006, 100% financed by public funds.

Its objective is to identify and assist the development of all forms of innovation and to assist the realisation of buildings able to demonstrate the ability of their designers to achieve rehabilitated buildings reducing by a factor of 4 their CO_2 emissions or new buildings reducing these emissions by a factor of 7 or 8, or even being net producers of energy.

The R&D programmes in energy efficiency should benefit from the support of the community Framework Programme for Research and Development.

The issues of creation of jobs as researchers and engineers in research centres and consultancy firms are significant.

6.6. The issues of training workers in the whole of the branch contributing to the improvement of energy efficiency of dwellings.

The training needs of the "energy efficiency of buildings" branch were analysed in depth in the United Kingdom and in France.

United Kingdom

In the context of the objective of reducing CO_2 emissions in construction by 60% by 2050, and of the so-called "40% House Project" defined in the White Paper of 2003, training needs were analysed and evaluated, and programmes tried.

The government ordered successive commissions (Egan Reports in 1998, "Rethinking Construction" and 2004, "Skills for Sustainable Communities", report of the Environmental Change Unit, University of Oxford, in 2005) to define the appropriate measures to develop energy efficiency of buildings in the United Kingdom and more particularly in the field of training the players involved.

These two studies make similar findings and recommendations:

- To take up the challenge of achieving the goal of a 60% reduction in CO_2 emissions in construction in the United Kingdom in 2050, i.e. renovating 25 million dwellings and replacing 50 million heating systems functioning today essentially on gas or on fuel oil, incorporating low- or zero-emission technologies, the forward management of jobs and competences in the professional branch concerned will represent a crucial issue.
- There will be enormous opportunities as well as enormous risks for all professionals affected by this challenge in terms of activities, jobs, skills and training.
- The questions of human resources, underestimated by the majority of professionals concerned, are a significant hindrance to the transformation of the residential sector into distinctly less of a CO_2-emitting sector.
- Building professionals and those in the thermal material and equipment industries are generally averse to change, innovation and continuing education. Regulatory measures are therefore necessary to push these players to innovate and to develop appropriate training programmes.

  For example, in the United Kingdom, new constructions starting from 1 April 2005 are obliged to be equipped with condensing boilers. For this purpose a training module was first put in place by the state with the objective of training 70,000 installers in these technologies. In 2005, however, only 30% of this objective had been achieved according to the Energy Saving Trust.

- The issue is the same for the training of energy efficiency inspectors and auditors.
- Moreover, this professional sector is very atomised in its behaviour and has trouble developing partnership relationships between the various players both for R&D activities and for training.
- Training programmes in sufficient quantity and quality must involve all the players in the enlarged sustainable-building branch, the public authorities financing the programmes and training professionals, and even including researchers into new technologies of thermal construction and renovation of buildings.
- The public sector must play a key leadership role in implementing demonstration projects, not only of dwellings with low CO_2 emissions, but also demonstration training programmes appropriate to the issues.

- These training programmes must not be limited to workers in the enterprises concerned, but also the whole range of players concerned with habitat and town planning, even if the content should be less technical but more organisational, economic and behavioural in nature: officials and decision-makers in local councils, neighbourhood and residents' committees, journalists, teachers-educators, school pupils and tertiary students, residents themselves…

Opinion and recommendations of the Economic and Social Committee in France.

The Economic and Social Committee, on 26 April 2006, in its report and opinion, following a government referral, entitled "Les politiques de l'habitat et de l'urbanisme face aux changements climatiques" (Habitat and town planning policies in the face of climate change), put the emphasis on the issues of both R&D and training in this sector.

The construction sector is currently experiencing favourable economic conditions, even overheating. But it is confronted with major problems with recruitment of qualified personnel and with training, in both quantity and quality.

Training provisions in the construction sector in Europe are generally narrow in scope and poorly financed, especially if they are provided by professional centres in the sector, inasmuch as there constraints on financing by this sector, ¾ of which is made up of small or even very small businesses, but also constraints on the availability of company heads and employees.

There is a great risk of continued education being essentially provided by the services of large manufacturing and, in particular, distribution companies. These initiatives, while they open the professional world to innovation and in particular to the improvement of energy efficiency, risk destroying the independence of tens of thousands of tradesmen and project managers in Europe, and biasing the information and advice given to households.

In relation to the objective of energy savings in the residential sector, the demands on all initial and ongoing training measures are twofold:

- to initiate and train people for occupations in environmental quality in 3 indispensable areas: prior diagnostic techniques, knowledge of all renewable energies and their specific conditions of use and installation in the light of their respective performances
- Reorient or revise the contents in vocational training to emphasise certain contents, for which the demand will be on the increase: insulation and ventilation, heating grids, interior equipment.

In terms of the policies and measures required in the training area, this could be translated as follows:

- Revise the content of initial professional training courses in the construction sector. Public authorities need to ensure that the contents of existing training courses incorporate environmental and energy concerns and the new training types so as to speed up the validation of the corresponding diplomas.
- A new priority for continuing education programmes These programmes must favour, in a voluntary way, the emergence of new occupations and reskilling incorporating the elements of energy efficiency, CO_2 emissions, and climate change. Local and regional councils must play their role of taking stock of the competences required in the emerging disciplines and initiating a common programme of training the trainers. Moreover, the state must ensure that the development of initial and continuing training is organised in partnership with all players in the branch.
- Expand access to continuing education. This requirement will be translated by:
  - ⇨ Increasing the financing facilities for training
  - ⇨ Increasing the availability of employees and employers to undertake training.

Each local public authority, should, in accordance with the usual methods of forward employment planning and taking account of the acceleration of retirements and of the demand for employment in these occupations, establish the qualitative and quantitative objectives for continued education for the 5 years to come. This would allow an estimation of the shared financing effort between public funds and private sources of finance. This effort to improve access to continuing education would in fact be useless if the percentage of employees, employers and trainees (students and *not* job-seekers) did not increase significantly in the coming decade.

- Training for project management occupations. This has been a recurrent question for many years. In fact, conflicts of interest and of culture are rampant between professional groups, in competition on all private and public contracts and most particularly between architects and engineers of all types. The explosion of consulting firms and engineering businesses has contributed to limiting substantially the contributions of architects as project managers. Their training in general does not prepare them to take on new technological challenges, notable bioclimatic and energy-efficiency challenges. Therefore, the initial and continuing education of both engineers and architects should incorporate these dimensions in order to develop these new competences in these professions.

The issues around the emerging new profession of energy auditor

The European Directive of 2002 provides for a compulsory thermal diagnostic for a part of the building stock in the European Union and has given rise to the development of a new occupation: that of energy auditor. Around 25,000 energy auditors ought to be created to apply the directive.

In many European Union countries, training for this new occupation, fundamental to laying the foundations of the development of investments and activities in the energy renovation of buildings, has posed major problems. The competence and skills of these professionals need to be specified and validated by an accredited diploma.

The Economic and Social Committee in France asks that the thermal diagnostic provided for by the European Directive of 2002 be rapidly put in place and supplemented for every building intended for collective usage by a "carbon account"; the energy efficiency process should therefore be given the additional goal of reducing CO_2 emissions.

Endowed with a quasi-official responsibility, the new profession of energy auditor should be strictly and ethically independent, in particular from real estate agents, building management agents, notaries, and construction professionals. There should be certification to allow the public to identify them. Energy auditors would have the responsibility of providing an expert opinion on real estate the content of which would correspond to a procedure strictly defined by the public authorities and with no prescription of works to be performed. It would be a good idea if from now on the training of these experts, who will have to participate from 2007 in all real estate transactions, should be undertaken by the various training bodies.

The issues around the creation of a basic and continuing training scheme for the new emerging job of project management assistant

To make the implementation of energy efficiency and CO_2 reduction actions in buildings and dwellings in the public sector (national and local) efficient, it is necessary to the create the function of project management assistance with the public authorities concerned; it should be independent, multidisciplinary, experienced and therefore trained for a genuine public service vocation.

In fact such a vocation requires at the same time:

- to combine the competences exceeding by far the demands of a single discipline (architecture, engineering…) as well as solid experience.
- to display a certain ethic and independence in relation to large groups, multinational

building companies, energy operators, and players in many professions.

All schools and universities that train for public management ought to integrate this dimension into their continuing education courses.

7. Impact on employment of horizontal policies and measures

7.1. cross-sectoral technology

CO_2 capture and storage

CO_2 capture and storage might have a role as a transition technology helping to move towards a lower-carbon energy system. IEA modelling results suggest a potential of 400 to 800 Mt of CO_2 capture in Europe by 2030 (EEA 2005, 52).

Implementation conditions (geology, transport, economic aspects, etc.)

The problem is mainly with the ability to open up the storage possibilities. A certain number of conditions must be combined for storage options to be considered suitable.

Impermeability of reservoirs

An essential condition for creating a geological CO_2storage site is of course confirmation that the storage facility would be secure for a period of hundreds or even thousands of years. Massive leaks from the reservoirs, quite apart from representing a potential danger for nearby populations, would effectively cancel out the benefit of the injecting CO_2 in the first place.

Investigations of proposed storage reservoirs will need to show that all the conditions for long-term impermeability are fulfilled (e.g. presence of a clay layer and low seismic activity). With regard to saline aquifers, which as we have seen represent the largest storage potential, investigations must show that there is no risk that acidification resulting from the CO_2 injection could dissolve the rocks around the aquifer, which could allow the CO_2 to migrate and escape to the surface.

Transport problems

Since the CO_2 will not necessarily be "produced" by an industrial unit situated in immediate proximity to the storage sites, the CO_2 emitted will have to be transported.

CO_2 can be transported from the point of capture to point of storage by pipeline or by boat; transportation by lorry or train would appear to be less suitable for the volumes concerned.

The advantage of pipeline transport is that it is already well controlled: pipelines for transporting natural gas in conditions similar to those required to transport CO_2 are well developed, and CO_2 is already being transported in the United States which has a network of 3,000 km of pipes carrying CO_2 between natural CO_2deposits and oilfields.

Boat transport offers more flexibility and the cost varies little regardless of the distance covered. It does not require the construction of a pipeline, but does require liquefaction units and harbour infrastructure.

The cost per tonne of CO2 "avoided"

Estimates of the cost engendered by implementing CO_2 capture and storage vary widely for various reasons: the techniques to be deployed are still not well known on an industrial scale, the nature of the emitting source and the capture method, the transport distance and the geological milieu chosen for storage may greatly affect the cost.

Estimates therefore range from $15/t or $38/t for BRGM to $42/t to $90/t for GDF. In any case, these costs are currently distinctly higher than the CO_2 price set on the exchange and will need to be lowered through technical improvements in order to become economically viable. This is all the more true given that these estimates are based on costs per tonne emitted and that it has been observed that emissions increase significantly when a capture unit is deployed.

Furthermore, while such technology will not be broadly available before 2020, at this time, renewable energy technology might already have nearly reached the break-even point and will be the substantially cheaper option to reduce emissions.

Experiments

The Castor R&D project, launched in February 2004, combines research bodies, oil companies, electrical contractors and electrical equipment suppliers. This project involves the post-combustion capture of CO_2 at a coal-fired power station at Ejsberg, Denmark and investigations at four storage sites in Europe: a petroleum deposit in Casablanca, Spain, a gas-field at Atzbach-Schwanenstadt, Austria, an aquifer in Snohvit, Norway, and a gas-field (K12B) in the Netherlands.

In Norway, the CO_2 emitted by the Sleipner gas-field is re-injected into a saline aquifer at a rate of 1 MT a year. This programme has been conducted by Statoil and Total since 1996.

In Weyburn, Canada, CO_2 is injected into a gas deposit as part of an Enhanced Gas Recovery (EGR) programme. The interesting feature of this programme is that it involves with CO_2 captured at a thermal power station in North Dakota and transported 300 km by pipeline.

The DF 1 project in Scotland brings together BP and Scottish Energy at a unit generating electricity and hydrogen by steam reforming, with capture of CO_2 and its injection in the Miller Field oilfield.

Total is to launch a pilot industrial demonstration at Lacq with oxy-combustion recapture at a revamped thermal power station and injection into a depleted gas deposit.

Impact on employment

At the level of capture: CO_2 capture at a power station or any other CO_2-emitting facility does not represent a potential for creation of additional jobs over those already existing, or only to a very marginal extent. The only possible source of additional employment would be within the companies manufacturing and installing capture units.

Transport: transport (by pipeline or by boat) represents a small number of jobs per kilometre covered. In contrast, the construction of infrastructure could generate a more significant volume of activity but over a limited time.

Storage: the number of jobs needed for injection into reservoirs is comparable to the number required for extracting petroleum. Offshore oil platforms could have their lifetime prolonged after resources have been extracted from a deposit by being converted to injection sites.

In contrast, the impact CCS technologies could have on employment is considerably greater in the sectors that are potential users, such as coal-fired power stations, cement producers, the hot phase of the iron and steel industry, in terms of maintaining existing activities and jobs (rather than destruction-creation). The technologies would allow these industrial production units, whose activities can be relocated to countries with no or only weak environmental restrictions, to significantly reduce their CO_2 emissions without recourse to very costly investments in breakthrough processing technologies.

Hydrogen

In how far a hydrogen economy with stationary and non-stationary fuel cells will be established and in how far fuel cells will be using predominantly natural gas in the course of the next 20 to 50 years, is controversially discussed among experts. Establishing a hydrogen fuel cycle would need large investment in new infrastructure and technology for production, transport, storage and use. Furthermore, a central question in judging the technological, market and social impact is the origin of the hydrogen fuel: production from renewable energy sources, nuclear, or fossil fuels. A sustainable energy system can only be achieved with hydrogen production from renewable energy sources. However, the potential of renewable sources to be used for hydrogen production is limited in the EU. For example, for Germany, this might be an option only slightly starting not before 2025.

Until then, there are more efficient and less costly alternatives to bridge the possible gap between supply and demand.

There are no reliable estimates of the employment impacts of fuel cells and other technologies and infrastructures of the hydrogen chain yet. What is known today, are e.g. the production expansion plans of manufacturers. For example, Sulzer Hexis in Germany plans to increase the number of employees from currently 35 to 200 persons in the course of the coming years, Siemens Westinghouse in Pittsburgh (USA) from 150 to 450-500 employees, i. e. about one person-year per 200 kWel of production capacity.

7.2. Kyoto project-based flexibility mechanisms (CDM, JI)

These mechanisms can be used by States to meet their Kyoto Protocol targets, and by companies covered by the EU Emissions Trading Scheme (EU ETS) to meet the emission quotas allocated to them under the national allocation plans (for the EU ETS).

The only assessment available on the impact of flexibility mechanisms on employment is the study conducted by the European Commission prior to the legislative proposal establishing a link between the EU ETS and the Kyoto mechanisms. This study considers that "any negative social impacts of allowing operators to use JI and CDM credits in order to comply with their obligations under the Community emissions trading scheme will be minimal."[57]

A new assessment of the impacts of project mechanisms on employment is nonetheless justified given the amount of CDM credits that the European States are already planning to acquire in order to meet their Kyoto obligations (520 million tonnes of CO2 eq over the period 2008-2012, worth ¾2.7 billion) and the structural role that this mechanism could play in the future, as described in the EEA nuclear scenario analysed in this study.

The analyses conducted as part of this study have yielded a number of points in reply to this question, notwithstanding that the subject deserves a more in-depth study.

A distinction should be drawn between investments in CDM and JI projects by the companies covered by the EU ETS and those made by States using public funds.

'Kyoto' credits purchased by companies

Compared to a situation without flexibility mechanisms, the opportunities afforded by CDM or JI credits for companies could have widely varying impacts on employment.

Positive impacts on employment could include:

- the possibility of saving jobs, in the short term, at industrial facilities that invest in CDM projects, by enabling said facilities to meet their emission reduction targets at a lesser cost than that of purchasing CO2 on the European market and the marginal cost of reducing emissions at the facilities;
- the spill-over effects on employment among European equipment manufacturers, whereby this mechanism would be comparable to an export subsidy for these operators;
- positive effects for the modernisation of industrial and energy tools in developing countries or emerging markets, with positive effects on employment in those countries. However, the level of job creation in the host countries cannot be estimated because impact on employment is not a criterion which the CDM Executive Board takes into account for approving project mechanisms.

Negative impacts could arise from:

- a situation where CDM investments in developing or emerging countries are either a) part of a foreign investment strategy which the company would have implemented even without the CDM or b) a strategy to avoid the carbon constraints that apply in Europe. In such a case, even if the CDM is not the reason for the investment transfer, it tends to intensify it due to the

[57] SEC(2003) 785

financial inducements that it can bring. This may be the case in a highly internationalised industry such as European steel, as we have seen. The total represented by CDM projects carried out to date in this sector is very limited, nonetheless;

- the failure to actually create jobs which would otherwise have been generated indirectly in the sectors benefiting from eco-efficient investments in the industrial facility using CDM (equipment, research, etc.);
- in the long term, the failure to upgrade the company, which will result in a competitive disadvantage when the carbon constraint is stepped up and implemented across the board.

'Kyoto' credits purchased by States

State investment in CDM projects is different insofar as the aim is to meet the country's Kyoto targets and the investment is financed from public funds.

Positive impacts on employment may result chiefly from the economic and social risks of reducing a country's emissions within a short period of time (2008-2012), when the country is facing high reduction costs owing, for instance, to the rigid nature of energy systems (Italy) or the virtually uncontrollable nature of transport emissions (Belgium). The cost of the adjustments is thus passed on to the public purse, i.e. the taxpayer.

Nevertheless, if a country's dependence on flexibility mechanisms becomes structural in the medium or long term, there is a risk that the public budget allocated to the CDM investment will rise as the less costly CDM projects are implemented in host countries at the expense of alternative uses that would generate jobs at home.

For that matter, the CDM mechanism has no device for ensuring the employment benefit of CDM projects.

Beyond the negative impacts on employment, excessive use of flexibility mechanisms by States would entail other costs. It would deprive people of the shared public health benefits of greenhouse gas reduction, particularly the most destitute in society who are the most exposed to such problems. Furthermore, the EU's credibility on the international climate change scene would suffer from an excessive use of flexibility mechanisms.

8. Conclusion of the second part of the study: potential impacts on global and sectoral employment of CO_2 emissions reduction measures

8.1. *The impact on direct and indirect global employment in the four sectors studied (energy generation, transport, steel and construction)*

Bearing in mind the limits of the methodology used in this study – which are inherent to a meso-economic approach – it is possible reach conclusions regarding the impacts on employment resulting, directly or indirectly, from the implementation of climate policies in the sectors included in the study.

The study estimated the nature and scope of the balance between risks and opportunities by examining projected jobs under various alternative emission reduction policy scenarios for meeting the EU's targets by 2030 (cf. graph II.21.).

Weighing up these sectoral effects indicates that ambitious emission reduction policies well beyond the 2012 deadline should not cause overall job losses in the European Union.

On the contrary, such policies make a positive contribution to global employment, because the economic activities to be developed (insulation, renewable energies, public transport, etc.) are much more labour intensive than those whose volume must be reduced, i.e. primarily the generation of non-renewable energies and private transport.

Nevertheless, sizeable and regular job cuts have occurred in recent decades in many of the sectors studied (power generation, rail transport, construction in certain Member States, steel, cement), for reasons that have very little to do with environmental regulations and far more to do with liberalisation and privatisation, technological progress and globalisation.

Current projections point to similar developments in the coming decades, albeit to a lesser degree. This is the case for power generation and industrial sectors, especially in the new EU Member States.

Accordingly, the application of European climate policies in these sectors is likely to have a substantial impact in terms of saving jobs that would be lost if no climate-protection measures were taken.

Furthermore, substantial productivity gains can still be expected in the coming decades in job-creating activities geared to the fight against climate change, in particular renewable energies and construction, which are undergoing a process of industrialisation.

It is therefore difficult, at this stage, to view climate policies as a way of making major inroads on unemployment, which currently affects almost 17 million people in Europe.

8.2. *Activities with "winning" and "losing" trends in relation to the BAU scenario*

The sectoral analyses and assessments conducted at national and European level under this study show that voluntary scenarios to reduce CO2 emissions in the medium and long term will have a rather sizeable impact on employment through direct and indirect intra- and inter-sectoral flows.

The impact of climate policies on sectoral employment by 2030 may be assessed firstly against a trend scenario describing the future development of the sector if no additional policy or measure is adopted and implemented. This approach is useful for anticipating the new developments that actors in the sector (managers, trade union organisations, etc.) will have to manage in the medium and long term.

A risks and opportunities assessment

The sector-specific impact on employment must be assessed in terms of **risks and opportunities.** This is a more pertinent characterisation than that of "winning" and "losing" sectors from the employment perspective. In fact, in each of the sectors under study (power generation, refining, transport, steel, and construction), the implementation of climate policies creates, by comparison to the trend scenario, both positive opportunities and risks in terms of creating/destroying jobs and of improving/deteriorating job quality.

The risks and opportunities created by emission control policies leads to a re-assessment of the added value and employment in the sector and to their redistribution among the actors according to the actors' strategies and their capacity to take advantage of the opportunities and to manage the risks.

A good example is the power generation sector, where the boom in renewable energy sources brings added value and new jobs that can be capitalised on by newcomers in the sector (large power and oil groups, SMEs) and traditional power companies.

Similarly, the development of energy services for industrial and private consumers combined with energy efficiency constitutes an opportunity to create jobs for the power generation and distribution sector, but the power suppliers will be only one of the actors involved in these new developments.

Dynamics at work

There are approximately three different underlying trends in jobs created by climate policies and measures in the sectors covered by the study up to 2030, irrespective of the planned policy scenarios and measures for reducing emissions.

The first is a transfer of jobs from power generation activities to activities relative to energy efficiency and the reduction of power consumption, i.e. power-using sectors investing in the efficiency and reduction of their consumption and energy services. This trend results from lesser growth, or a drop in consumption and power generation capacities.

The second trend concerns a transfer of jobs from goods road transport and the private car to public transport activities for freight (rail and navigable waterways) and passengers, as a result of readjustments in the modes of transport and reduced growth in freight activity.

The third trend results from the internal substitution effects on equipment industries, with jobs created by the design, engineering and construction of equipment for power generation from fossil fuels and private road transport (trucks, cars) being replaced by jobs in the equipment sector for renewable sources of energy (wind, solar energy) and co-generation, for energy efficiency goods and services, possibly nuclear energy, and rolling stock. A good example of this inter-sectoral trend is the foreseeable switch from combustion to electric engines, with jobs in electrical construction replacing those in smelting works.

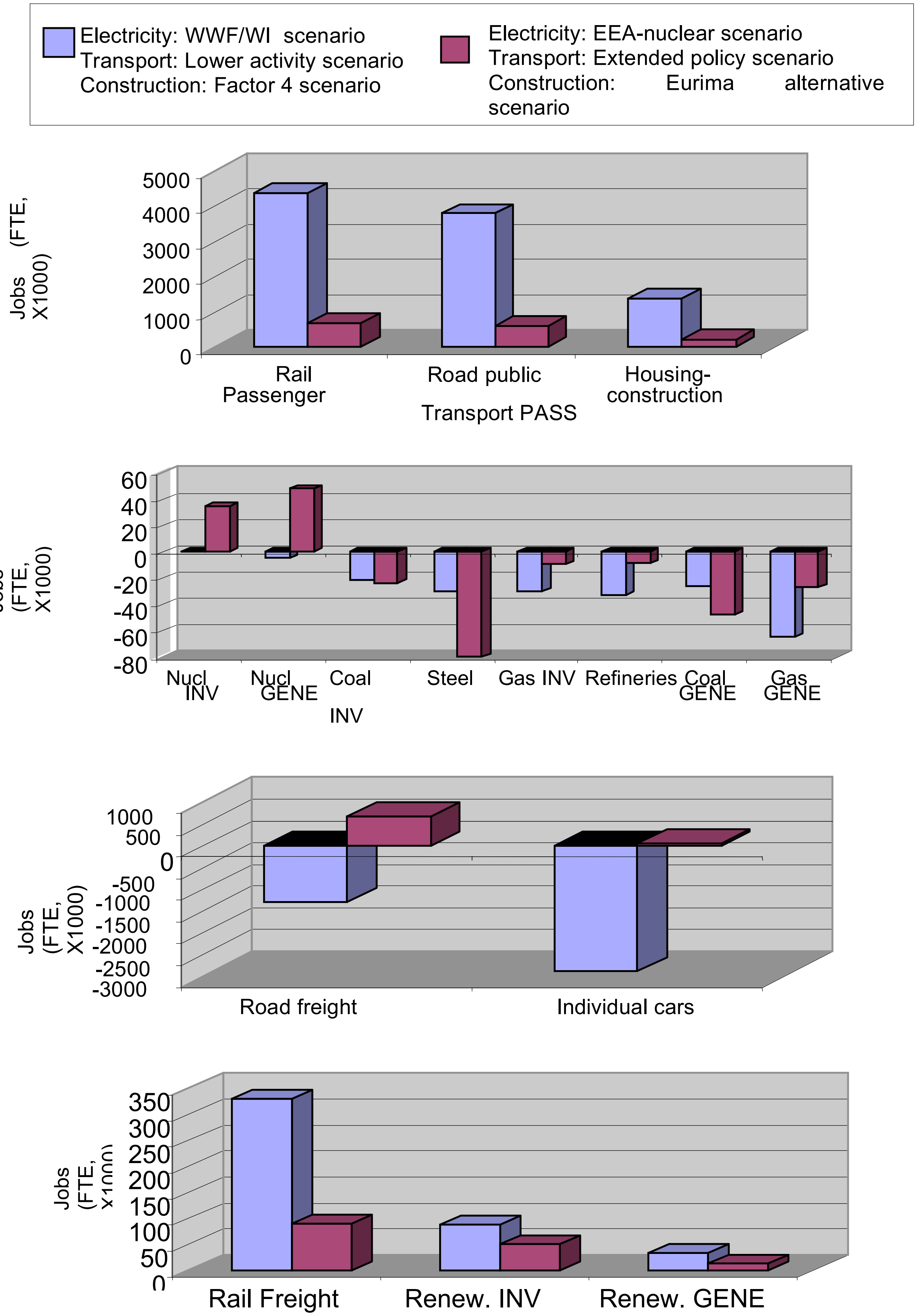
Activities with positive, negative and unknown trends

The CO2 emission reduction process entails opportunities and risks for each sector. There are activities where the balance of risks and opportunities is clearly positive, activities for which this balance is clearly negative, and activities for which the result is uncertain

Activities with positive trends

The **construction industry** clearly belongs to the sectors where employment should benefit from the development of climate policies and measures. Beneficiaries include in particular construction and public works companies, manufacturers of durable building materials, installers of low CO2 emission and solar energy boilers and designers and manufacturers of

Fig. III.21.: Employment impact of alternative scenario compared to BAU - 2020/2030



thermal management and heat regulation systems (house and building automation). This potential benefit derives from two sources: a) needs linked to the insulation and energy renovation of buildings for energy-saving purposes, and b) construction and installation of the infrastructure needed to cope with changing transport and energy demand.

Certain **industrial branches** will undoubtedly benefit in terms of jobs These are industries:

- that design and manufacture the materials and equipment of all renewable energy sources and less carbon-intensive energies (essentially gas) as well as co-generation;
- electrical equipment manufacturers and heating equipment industries for investments in energy efficiency in the residential and tertiary sectors;
- manufacturers of rail equipment, suburban trains, undergrounds and tramways (engineering, rails, electrification, telecommunication safety and signalling equipment, rolling stock);
- the construction of new power transport lines to connect new generation sites, in particular those generating renewable energies;
- the development of new automotive technologies to adapt vehicles to all clean energies: natural gas for vehicles (NGV), liquid petroleum gas (LPG), diester, diesel/electric hybrid vehicle, power supply by line, on the ground or by battery, etc.

Moreover, these industries should benefit from substantial exports of low carbon emission technologies.

Operating and maintenance activities for **power generation from renewable energy sources** (wind, solar, hydroelectric, biomass, geothermal, tidal, waves) will undoubtedly require a considerably larger workforce.

More exacting objectives for higher energy efficiency will have positive repercussions on the number of **energy savings consultants and engineers,** as well as **energy service** providers, the latter being chiefly power suppliers, providers of operating services (heating grid management, energy maintenance, etc.) and installers (design of co-generation units or internal grids, for instance).

Jobs related to **power generation using natural gas,** which is currently booming in the liberalised electricity market, will continue to increase, given the prospective improvements in efficiency, the rapid return on investment and their relatively low impact on the environment, but with the danger of being dependent on a fuel whose price is volatile, whose reserves are diminishing and whose supply sources are less secure than coal and renewable energies.

Rail transport, both passenger and freight, as well as modes of urban public transport (tramway, bus, underground), should also benefit from a positive trend in employment resulting from the readjustment of private passenger transport (private vehicles) and road freight in favour of rail and modes of public transport.

Activities with a negative trend

The numbers of people employed directly in **power generation from coal** will most certainly decline considerably in Europe, irrespective of the hypotheses on the future of nuclear energy. The only factor that could reverse this trend would be the maturity of CO2 capture and storage technology by 2030.

Employment in the **refining** sector should drop because of the partial replacement of petrol with organic fuels in the transport sector and the tightening of carbon constraints in national allocation plans. The study has estimated this impact at between 15,000 and 48,000 jobs.

Activities with an uncertain trend

In the globalised **steel industry,** there is no doubt that unless the current policy to limit emissions is adapted, the gradual reduction of quotas attributed to cast-iron and steel production sites will continue to take its depressing toll on employment, through more outsourcing, less job security and the relocation of the liquid phase to low-cost countries without carbon constraints. The impact is estimated at 54,000 direct, outsourced and in-house jobs.

Conversely, an industrial policy for the steel industry that would make the carbon constraint into a factor of competitiveness for European steel in future would limit the impacts on employment and keep most of the jobs potentially threatened by the relocation of the liquid phase.

The employment trend in **road freight transport** is highly susceptible to the hypotheses concerning transport demand control. If there is no voluntary reduction in transport demand, a limited level of modal transfer should enable the number of jobs to continue to grow at a rate equivalent to that of the trend scenario, through the rapid adoption of new alternative fuels and new automotive technologies. Conversely, if road transport activity had to be reduced, the impact on employment, which is still positive, would slow down compared with the trend scenario. To be able to reverse the employment trend, freight activity would have to be reduced considerably, by about 30% between 2000 and 2030.

Employment in the **automotive industry** could decline compared with the trend scenario owing to policies intended to limit transport activity and readjust passenger transport modes in favour of rail. Nevertheless, in this case, job numbers would remain stable over the entire period (2000 to 2030), in particular because of the increase in added value from the dissemination of clean technologies.

The scenarios for **nuclear-generated electricity** have yielded uncertain results, inasmuch as job numbers could either increase or decline as a result of climate policies. This illustrates the great variations in policy choice on this matter among EU countries. It is interesting to note that the EEA nuclear scenario does not provide for an increase in the share of nuclear generation in the energy mix between 2000 and 2030, and still requires that a significant proportion of emission reductions be achieved outside the European Union. Nor does it exclude a not inconsiderable increase in the share of renewable sources in the energy mix.

8.3. *Employment adjustment capacity factors*

Activities with a positive trend: training and appeal

For activities with a positive trend, the growth expected in the relatively short term makes it all the more important to ensure that jobs are attractive enough so that a sufficient number of professionals and workers will want to go into those lines of business. This is a challenge especially for the construction industry.

At present, the potential in terms of training programmes and sites and competent trainers in these areas is insufficient to meet current and future needs. These sectors are also entering a period of high employee turnover, as many baby boomers approach retirement – something that could worsen the skills shortage.

Experience in the field and the results of interviews show how, beyond the training programmes needed, the positive trend in these activities can help to offset the decline in job numbers in activities with a negative trend through vocational mobility opportunities.

For some of these booming lines of business, such as energy efficiency auditors, the need for further training for current professionals could be quite limited; for example, as the European Federation of Building and Woodworkers (EFBWW) has suggested, older workers in the construction sector suffering from the onerous nature of their work could be retrained to take on these jobs.

The renewable energy equipment manufacturing sector may offer opportunities for retraining workers in regions where the metal, plastics and electronics industries are disappearing.

In the transport sector, there have been successful examples of drivers of heavy goods vehicles being retrained to work in public passenger transport (buses and trams).

Activities with a negative trend: the transition period and retraining

A proactive emissions reduction policy raises the question of the impact on wage-earners who depend, directly or indirectly, on negatively impacted activities. This impact will vary depending on several factors, two of which should be highlighted with a view to optimising climate change policies: the transition period and the capacity to retrain affected workers.

- The transition period. The social cost can be limited by thinking carefully about how emission constraints are raised so as to give workers threatened with losing their job the time to adjust. As we have seen in the refining sector, such adjustment in sectors with an ageing workforce should be carried out gradually, taking into account jobs lost to retirement and not replaced.
- The capacity to retrain affected workers. We have seen that, in the energy sector, workers in coal-fired power plants can be transferred to other thermal power plants through limited investments in additional training.

Manufacturing sectors: R&D and easing competitive pressure

The future of employment in the steel industry, which is subject to tough carbon constraints on its industrial processes, and in the automotive sector, where the carbon constraint tends to focus on production, would seem to depend on three factors:

- The capacity to disseminate and adopt, on a large scale, processes which are technically possible today (e.g. hybrid motors for cars) and to push back technological boundaries through innovation. The challenge is to turn the carbon constraint into a competitive advantage for European manufacturers by consolidating and enhancing their technological excellence in production and the use of limited emission technologies.
- Easing the competitive pressure exerted by manufacturers in countries that have not applied an equivalent carbon constraint on their manufacturing industries, so as to maintain the production capacities and jobs that would otherwise be threatened by relocation to those countries.
- The size of companies: small and medium-sized companies do not have the flexibility to transfer CO2 emission rights from one production site to another within or between countries, unlike large groups which also have the human resources needed to tackle the requirements imposed by environmental regulations.

Part IV

Recommendations for optimising synergies between climate and employment policy

The following document sets out the instruments and policies that could have the biggest impact in terms of optimising synergies between climate and employment policies. These recommendations could potentially help to:

- make climate policies and impacts of climate change easier to predict so that economic and social changes can be anticipated;
- maximise positive spin-offs for quality job creation;
- support the changes in employment resulting from emission reduction policies and from climate change.

1. Make climate policies easier to predict and so anticipate the necessary social consequences and ruptures

It is vital to make climate strategies easier to predict over the medium and long terms so that effective anticipatory strategies can be developed and the necessary adaptation and support procedures implemented.

Uncertainties of all kinds, especially those affecting international post-Kyoto commitments, make it difficult to draw up long-term policies on cutting greenhouse gases. At the time of writing, only a minority of EU Member States have set emission reduction targets beyond the first application period of the Kyoto Protocol (2008-2012). Sectoral emission reduction targets are few and far between and only very rarely relate to 'difficult' sectors such as transport.

Failure to anticipate the necessary consequences and ruptures could necessitate readjustments when more restrictive measures are being taken, at very great cost to jobs.

This issue is a strategic one for all those areas where lifetime of equipments is longer than current horizon of climate policy, e.g. in the electricity sector and in energy-intensive industry, and where it is needed to build up human resources (by education and training) to implement climate measures, e.g. in the construction/refurbishment sector.

Furthermore, failure to properly anticipate could lead to the juxtaposition of divergent anticipatory procedures and strategies by economic, social and public players and NGOs, making it difficult to meet medium- and long-term objectives.

EU greenhouse gas emissions targets can only be met through clearly stated public objectives. This requires:

- the EU to adopt an offensive position in international negotiations, to get industrialised countries currently outside Kyoto, and eventually emerging countries too, to rally to the cause of tackling climate change;
- the urgent adoption by the EU of quantified, independent and binding targets for medium- and long-term reductions in greenhouse gas emissions, thereby ensuring the continuity of the European emission quota trading system;
- in the difficult field of transport, the adoption of strategic emission reduction targets for each mode of transport, in the medium and long terms;
- in the new Member States in particular, better information and training for economic and social players and trade unions, as well as exchanges of experience and expertise on tackling climate change and its economic, social and environmental implications.
- Launching national and European forecasting exercises, with alternative scenarios as regards possible emission-cutting policies and measures, with a view to ensuring sustainable development that balances the environmental, economic and social dimensions, would generate a common understanding of what is needed to meet the EU targets. Like the forecasting being done in the UK (Stern report), France (Factor 4) and Germany, these exercises should bring together all stakeholders and cover all relevant sectors.

2. Climate policies and measures to maximise positive spin-offs for employment

The analysis highlighted the potential that exists for new business activities and jobs associated with major reductions in greenhouse gas emissions in the EU. Such jobs will not be created spontaneously at optimal level, making it essential to implement proactive policies in support of the expansion of activities that clearly create jobs or ensure the continuation of existing jobs while reducing greenhouse gas emissions.

The set of policy recommendations falls within the scope of a European industrial policy approach that should include, but not be limited to, support for research and development, and should cross sectoral and transversal dimensions (public investment, regulatory instruments, R&D, market instruments, trade adjustment mechanism to rebalance carbon costs of imports, training, providing social and economic support for employment transition, social dialogue).

2.1. Mobilising substantial and appropriate public resources to implement public and private investments in goods and services responding to the challenges of climate change

The economic consequences of the transition to a low-carbon economy must be fully recognised, in particular the scale of additional public and private investments that will be needed to renovate gradually existing capital stock in the European Union. To support such investments, the following measures and initiatives must be put in place.

Enhance combined heat and power generation and fully exploit the potential for greater energy efficiency

The improvement of energy efficiency on the side of energy demand (e.g. for more energy end-use efficiency) has important job-creating potential.

By developing the market of energy efficient services, in accordance with the directive on energy end-use efficiency and energy services, gas and electricity suppliers could create jobs that would at least partially compensate for those lost as a result of lower energy consumption.

Combined heat and power production solutions should be strengthened and the full potential of energy efficiency should be harnessed by combining:

- the establishment of more demanding targets for energy efficiency gains;
- tax and financial incentives;
- information and awareness actions;
- European standardisation and labelling;
- the promotion of energy consulting and audits;
- the introduction of energy efficiency in public procurement procedures.

The housing sector holds considerable potential for unrealised energy savings that can be achieved in an economically profitable way, which represents an important pool of economic activity and jobs and would respond to social concerns by reducing household energy bills, thus reducing the 'fuel poverty' phenomenon.

The European Union must encourage the Member States to adopt programmes to improve the energy efficiency of housing, in particular the new Member States, which have important energy savings potential. To support Member State financing, it must mobilise new European funds, credits under the European Structural Funds and European Investment Bank (EIB) resources, including the guarantee structures for the renovation of buildings to lower their energy consumption.

The directive on the energy performance of buildings should be extended to all buildings, including small ones and those for low-income segments of the population. There will be a need to train more professionals to raise the current level of implementation of the directive on energy performance of buildings.

Strengthen support for renewable energies to increase their share in energy consumption to 20% in 2020

Renewable energies enable a net gain in jobs as they replace activities with a much lower employment density, namely non-renewable energy generation. Currently, investment in renewable energies is unevenly distributed, with three countries (Germany, Denmark and Spain) accounting for the bulk of facilities and associated industrial capacity.

The share of renewable energies must be raised significantly in all the EU Member States, so as to achieve, in 2020, the firm objective set by the European Council in March 2007 of raising the share of renewable energies to 20% of energy consumption.

- Support measures should include: national objectives for renewable energies enabling them to reach the critical market size to make them competitive without long-term subsidies;
- R&D and support for renewable energy industry;
- Training, especially for maintenance activities;
- Better working conditions in operating and maintenance activities.

The continuity of programmes of support for the renewables market is essential, as demonstrated by the case of Germany in solar and wind energy.

Support modal shift by investing in European transport infrastructure

Investments are imperative for restoring balance on a sustainable basis to different modes of transport, reducing the use of passenger cars and the road transport of freight and stepping up the use of public transport, rail – for freight and passengers - and navigable waterways.

Such a transfer will create large numbers of new jobs, both for exploitation and infrastructure works.

The European Union must give impetus to trans-European infrastructure works in railway, piggy-back transport, navigable waterways and the installation of hydrogen refuelling infrastructures ('hydrogen motorways').

Innovative means are needed to fund them: a new European tax on civil aviation fuel and/or heavy tonnage shipping.

2.2. A greater effort in research and development to achieve the technological, organisational and societal changes required

Innovation has a crucial role to play in stimulating new technological breakthroughs that will transform the carbon constraint into a competitive asset for European companies and create new jobs and preserve existing ones.

The sectoral analyses carried out for this study have shown that technological breakthroughs that will allow substantial reductions of CO_2 emissions are possible, with industrial-scale generalisation anticipated by 2020.

Moreover, research and development spending has in itself a high employment content. It is estimated that approximately 500 000 additional researchers would be needed to meet the EU Barcelona R&D spending target of 3% of GDP in 2010[58].

Massive push by governments

A major push from governments is needed to offset the diffidence of private R&D initiatives highlighted by the report. Europe must plough far more funding into R&D than it is doing at

[58] Sheehan et Wyckoff (2003), "Targeting R&D: economic and policy implications of increasing R&D spending", STI Working paper 2003/8, OECD

present, in the fields of renewable energies, combined heat and power and technologies that reduce carbon emissions and facilitate efficient energy use.

One sector where a technology breakthrough is absolutely vital is transport, given the expected increase in traffic volume.

The minimum, therefore, that needs to be achieved is an increase in research budgets for low-carbon energy and technologies, as per the 7th framework programme for 2007-2013, as well as bigger EU budgets in these areas.

The European technology platforms most likely to meet the challenges of climate change, and which have known benefits for the environment, the economy and employment, must be established as Joint technology initiatives and receive both EU and Member State funding.

Trade union participation in technology platforms and joint technology initiatives will ensure that employment concerns are factored into innovation strategies.

Research capacity in the least advanced regions must also be strengthened and the research potential of the new Member States fully realised.

Improve dialogue between society and the scientific world

This dialogue is particularly necessary on the issues of nuclear energy and carbon capture and storage, in order to integrate the knowledge economy into the European social model.

Factor in organisational and social innovation

Innovation is not limited to the actual process of technological research and development. It includes organisational and social innovations (e.g. worker participation in Germany and Scandinavia, work organisation leading to acquisition of experience and responsibility), which must also be promoted.

Ensure socially responsible management of change resulting from innovation

As innovation generates changes, a framework is needed for socially responsible management of change in order to bring workers and stakeholders on board. This means that an active approach to restructuring processes is required.

2.3. Apply the polluter-pays principle while pursuing the multiple objectives of sustainable development

Introduce an environmental tax reform coordinated at European level

Tax instruments have a decisive role to play in providing incentives for lower-carbon behaviours and investments.

Environmental taxes have proven effective in cutting greenhouse gas emissions in the countries where it has been implemented on a large scale, notably Germany, Sweden, Denmark and the Netherlands.

The introduction of environmental taxes has important redistribution effects. To remedy this aspect, accompanying social measures will have to be implemented simultaneously with the phased-in introduction of the taxes to attenuate the impact of the measures on low-income households and energy-intensive sectors operating under international competition.

In addition, the introduction of tax instruments should ideally be coordinated at European Union level to avoid their use for purposes of economic competition by the Member States.

The question of a positive effect of CO_2 taxes on employment ("double dividend") is a subject of academic debate. In certain conditions, however, additional jobs could be created by redistributing the proceeds of environmental taxes in the form of a decrease in withholding taxes on work (e.g. a reduction in personal social security contributions).

However, different research projects concur in recognising that the jobs potentially created by such a mechanism would be limited in number. In addition, the taxation transfer mechanism must respect an essential condition, namely it must not weaken the financing of social protection and public services.

It consequently seems preferable to give priority to the option consisting of using the proceeds from the tax, at least partially, to finance fresh public spending that creates jobs and supports research and the deployment of alternatives to fossil fuels, for example, public transport and programmes for the insulation of older housing.

Combine transport charging and improving working conditions in the road transport sector

Improving social conditions in the road transport sector and applying the polluter-pays principle to transport are two possible measures that should be taken in conjunction with one another, since they are mutually supportive.

Improving working conditions in the road transport sector will be a key tool in reducing the modal share of this mode of transport, a crucial aspect of any policy to limit transport emissions. The competitiveness of rail - and hence of intermodal transport - in relation to road should be strengthened by ensuring that legislation on working and rest time is properly applied in the road transport sector.

In this connection, the necessity of applying the polluter-pays principle would warrant a European framework on charging for use of transport infrastructure, so as to internalise the external costs of the various modes of transport.

Such a measure must be accompanied by a strengthening and Europe-wide harmonisation of workers' rights in the road transport sector so that the increase in road transport costs resulting from the integration of external costs is not cancelled out by a decline in the social conditions and health and safety of drivers, as well as of other road users. This is especially important in a sector characterised by low profit margins, heavy pressure from shippers and industry and inadequate application of legislation on working and driving time.

2.4. Build the European carbon market on a genuine "low carbon" industrial policy

The CO_2 emissions trading scheme is an important instrument of the European system to combat climate change because it obliges undertakings to take account of the cost of emissions from their production processes.

The European carbon market nevertheless suffers from a number of functional problems that need to be corrected for the post-2012 application periods. The analysis of industrial sectors (iron and steel, cement, lime) shows that the allocation and trading system as currently conceived could, if accompanied by truly binding allocations, serve to prompt energy-intensive industries already operating on the edge of current technological frontiers, and which have to cope with strong international competition, to relocate outside of Europe to countries not imposing similar regulations. The result would be job losses or a freeze on investments in Europe and carbon "drain". In the iron and steel sector, it is estimated that around 50,000 jobs could be threatened out of a total of 350,000 workers in the EU 25.

A number of ways have to be considered to transform the carbon constraint into a strength for Europe's carbon-intensive industries.

- Extend the duration of quota allocation in order to adjust the reduction in allocated quotas for each facility based on the rate of return on investment;
- Determine the emissions quotas allocated to facilities based on a CO2 emissions standard for each production sector, corresponding to best available practices, and move towards European harmonisation of quota allocation methods so as to cancel out the effect of intra-European competition.
- Use the allocation of emissions allowances to develop producers' R&D initiatives that help reduce CO_2 emissions over the long-term.
- Introduce a product import regulation based on CO2 emissions standards for industrial products in order to rebalance the carbon

cost of products consumed in the EU and thereby offset the competitiveness deficit of European industry stemming from the policy of CO2 emissions reduction.

- Introduce a system enabling unions to monitor the national allocation plans for emission allowances, following the model of the sectoral dialogue round tables in Spain (cf Chapter 3.2)

2.5. Set social sustainability criteria for publicly-funded CDM and JI projects

Heavy use of the flexibility mechanisms by States in order to meet the Kyoto targets may be warranted, in the first phase of application of the Kyoto Protocol, by the social risk that would ensue if countries with high emission reduction costs had to cut their emissions within a short period of time (2008-2012).

Nonetheless, besides contributing to an overall emissions reduction, investments in CDM projects must be shown to be sustainable by proving that they generate a minimum social benefit.

The good example shown by Belgium should be kept up and extended to the other Member States. Belgium's federal government has introduced a system of social and sustainability criteria for use in the selection and follow-up of Kyoto projects.

The criteria approved by Belgium's federal technical committee, which comprises representatives from the civil service, employers, NGOs and trade unions, include:

- compliance by the project promoter with the principles of the OECD Guidelines for Multinational Enterprises, the eight ILO core conventions, convention 155 on occupational safety and health and convention 169 on indigenous and tribal peoples;
- social sustainability, including employment (number of jobs created, quality of jobs, development of skills, compliance with labour standards), access to essential services including energy services, and fairness.

The involvement of trade unions, alongside the other stakeholders, in defining the procedures for selection and follow-up of CDM and JI projects, is a key factor in the sustainable development process in this area.

3. Social policies and measures to optimise management of the social effects of changes linked to CO_2 reduction measures

HR issues, which are severely underestimated by the majority of professionals involved, if they are not dealt with and resolved in a serious and appropriate way, may be a major obstacle to transforming sectors in line with European CO_2 emission reduction targets. Dealing effectively with the social aspects and employment will therefore be necessary in order to minimise the risks of resistance to change.

Appropriate mechanisms and measures will need to be developed and implemented using an anticipatory, multi-level (sectoral, company, cross-sectoral, territorial, national and European) and multi-player (social partners, policy-makers and social players) approach, so that the necessary social transitions are managed effectively, rather than simply being imposed, and result in a net gain in quality jobs.

3.1. Mechanisms to offer workers security and help them adjust to structural skills changes associated with GHG reduction

Forward-looking management of jobs and skills: a tool for the social anticipation and management of change

We propose to use forward-looking management of jobs and skills (*Gestion prévisionnelle des emplois et des competences*, or GPEC, in French) and its associated tools to implement social support for policies on combating and adapting to climate change.

GPEC aims to anticipate and bridge the gaps between needs and supply with respect to workforce and skills, based on well-defined medium-term objectives, and involving employees in the context of a professional development project.

In the case of changes resulting from climate policies, the aim should be to avoid having to manage the ensuing major restructurings as they happen (i.e. under time pressure and without being properly prepared) and thus minimise the risks of social conflicts and tragedies.

Mechanisms should be set up at all levels at which GHG reduction and climate change adaptation policies and measures are implemented: i.e. company, sector, cross-sectoral, territorial, national and European. These mechanisms must be developed and implemented to take account, in particular, of R&D programmes and the increasing role of new technological and employment sectors.

To ensure efficiency, GPEC must be applied in broad employment sectors. National and European regulations will be needed to encourage employment sectors (which are mostly resistant to both the innovation and the training associated with change) to implement these mechanisms.

The aim would be, by means of social bargaining, to define, finance and implement the following mechanisms:

- Tools to assess foreseeable quantitative and qualitative changes in jobs and skills, in order to anticipate possible job losses (develop indicators and social scoreboard for companies and sectors).
- Identify groups requiring adapted and specific measures.
- Define and implement social support measures to assist with changes:
  - ⇨ ensuring that available training keeps pace with changes in the skills required on the labour market: training programmes, recruitment, adjustments to working conditions and time.
  - ⇨ individual career support for employees: skills assessments, accreditation of prior learning, job and geographical mobility, financial and social measures to help deal with job losses.

Career security: the cornerstone of a successful social transition

European guidelines on employment in the context of the Lisbon Strategy should be implemented wisely in order to ensure a proper balance between flexibility and security and thereby make it easier for companies and workers to adapt to the economic and technological changes associated with the process of cutting CO_2 emissions.

In this context, career security must be a central medium in applying anticipation mechanisms such as GPEC, with a view to socially optimising the career transitions arising from these changes.

Given these foreseeable changes, the age of linear career paths seems well and truly over: flexibility, career transitions and breaks will be the new rules of the game for workers in sectors which have hitherto offered optimum overall career security, sometimes even a job for life in the same company or sector.

In this context, the worker mobility which is to some extent required by climate change prevention policies will need to be founded on other guarantees ensuring the continuity of workers' rights as well as on the collective negotiation of new rights to support and manage mobility and transitions.

The responsibility for bringing about this security must be collective, shared between the company, professional associations, the authorities, social partners and workers themselves.

The process requires the construction of social bridges and the development and implementation of social support measures to assist with the changes that result in the job and geographical mobility of workers involved: skills assessments, accreditation of prior learning, lifelong learning programmes specially adapted to guarantee the employability of workers, mechanisms to help with retraining and redeployment, recruitment, adjustments to working conditions and time and financial and social measures to help deal with job losses.

The key factor in safeguarding workers from the impasse of unemployment and precariousness is their capacity to gain new skills and qualifications.

Given this, the definition and implementation of continuing training programmes needs to be reviewed, and such programmes provided in sufficient quality and quantity, if necessary with the assistance of the European Social Fund, using an approach based on partnership between all stakeholders: players in the sectors concerned, the authorities funding (or co-funding) the programmes, the social partners and training professionals - even, if possible, researchers working on the new technologies used in these sectors.

The training programmes should not be limited to workers in the companies and sectors concerned but should extend to all stakeholders throughout society (citizens, consumers, residents), even if the content will need to be less technical and more geared towards organisational, economic and behavioural concerns.

3.2. Social dialogue and collective bargaining instruments adapted to climate policy challenges

Rather than being mere spectators, workers' representatives must become actively involved in the strategic guidelines defined and implemented to tackle emissions. A number of social dialogue and collective bargaining instruments and mechanisms should be introduced, and existing ones strengthened and updated.

Create a European sectoral and cross-sectoral observatory on economic and socio-employment changes associated with the adaptation to climate change and greenhouse gas reduction measures

The aim of the observatory will be to develop tools to monitor, follow up, analyse and evaluate sectoral and cross-sectoral changes in the post-Kyoto era, with a view to assisting dialogue between stakeholders (government, employers, unions, NGOs) about how to anticipate and manage these changes.

It would be financed by the European Commission and the Member States and supervised by a steering committee made up of stakeholder representatives.

Set up dialogue bodies involving specific stakeholders in the fight against climate change

Taking as a reference the Spanish national pact on implementation of the Kyoto Protocol, concluded between the government, employers and unions (framework agreement), the aim would be to create such bodies at national, regional and European levels.

The Spanish national pact established inter-sectoral and sectoral dialogue bodies to deal with adaptation to climate change and greenhouse gas reduction measures with a view to reaching framework agreements. To this end, sectoral round table discussions were introduced in 2005 (in seven sectors: power generation, oil refineries, steel, cement and lime, glass, ceramics, paper pulp), with financial and logistical assistance from the government and regional authorities.

In this framework, regional conferences are also held to bring together sectoral and territorial issues and consider the drafting of regional climate plans.

At European level, this could take the form of a European tripartite dialogue platform on climate change, bringing together the European social partners and the relevant Directorates-General of the European Commission.

The platform's task would be to prevent, and provide social support for, negative social and employment repercussions, as well as to promote the social and employment opportunities created by implementation of climate policies.

In this context, it could be consulted regarding the social and employment dimension of actions undertaken by the European funds (structural funds, framework programme for research and development, European Regional Development Fund) and the European Investment Bank to assist with adaptation to climate change and cutting greenhouse gas emissions.

Another of its objectives would be to develop tools and mechanisms for a new European industrial policy (R&D, instruments based on a system of standards, training, etc.) bringing together the sectoral and transversal dimensions and complying with WTO rules.

The European sectoral social dialogue committees should make adapting to climate change and reducing GHG emissions new collective bargaining fields.

New rights for workers' representatives

These new rights, which would apply at country, European Works Council and European sectoral social dialogue committee level and would focus on measures for adapting to climate change and cutting greenhouse gases, should involve the allocation of appropriate resources to information, consultation, participation and negotiation procedures for workers' representatives (operation, training, expertise, etc.).

Such rights already exist in some countries and regions of Europe (Germany, Flanders); the aim would be to extend them to all EU countries.

Introduce territorial social dialogue bodies to deal with changes resulting from climate policies

The key importance of GPEC actions undertaken at territorial level to optimise implementation of climate policies and measures makes it necessary to introduce territorial social dialogue bodies on these issues.

In many Member States, territorial authorities are major players on economic, social, environmental, urban planning and infrastructure issues, and develop and implement regional climate plans. The territorial level also offers room for manoeuvre when it comes to the social management of economic and technological changes.

Besides this, it allows workers from small companies to be integrated into the change management process.

The Nord-Pas-de-Calais region has shown that a regional climate plan can contain significant CO2 emission reduction measures and has demonstrated the importance of territorial social dialogue in defining and implementing regulatory and local and regional social support mechanisms for these changes - mechanisms co-financed by European structural funds.

At territorial level, multi-player social dialogue bodies are needed which bring together representatives of employers, trade unions, NGOs and territorial authorities and allow these players to engage in collective bargaining. Amongst other things, these bodies could be used to undertake joint assessments, analyse and assess local experiences, discuss what GPEC measures should be taken, follow up on past actions, organise transitions within the territory and develop public-private partnerships in order to secure funding from multiple sources, including Europe. Their members would be able to seek assistance from experts, researchers and consultants.

General conclusion

The work just presented sheds new light on the relationship between employment and climate change at European level in a long-term perspective (2030).

By comparing case studies from 11 Member States of the European Union 25 and European sectoral analyses based on alternative scenarios of $C0_2$ emission reduction policies, this study aims to assess the impact on employment by 2030 of both climate change, which has already begun and will continue, and of policies to reduce CO_2 emissions to limit the impact of global warming.

The first observation is that little is known about the connection between climate change and employment. In addition, decisions on climate policies are rarely assessed from the standpoint of employment. In the countries covered by the study, the issue of employment is discussed primarily to express fears about the impact of climate policies on industry and consumers, in the absence of comparable efforts by countries with which the EU competes. At this stage, climate change is seen as a scientific issue and, to a certain extent, as a political and economic matter. The idea that it is also a social issue, involving not only citizens but also all workers, is not yet sufficiently shared. Yet the first lesson of this study is precisely that no sector will be able to cut itself off from the consequences of climate change, whether it is directly affected by global warming or suffers the consequences, positive or negative, of measures taken to combat climate change.

Trade union organisations are rarely involved in decisions related to climate change. Huge disparities nevertheless exist between the union organisations from the old Member States, which on the whole are better informed about climate change matters, more involved in decision-making and more often take part in collective bargaining with employers on subjects relating to climate change or energy, and trade union organisations from the new Member States, which are largely excluded from decision-making.

Both the effects of climate change and measures adopted to reduce CO_2 emissions should have an appreciable impact on employment and economic activities in Europe through a structural redistribution of employment.

Impact of climate change on employment

The analysis of the relation between the likely effects of climate change in Europe, on the one hand, and economic activity and jobs in different sectors (agriculture, forestry, fisheries, tourism, finance/insurance, health, infrastructure and energy), on the other, show that even in the optimistic scenarios, based on gradual and moderate climate change (of some +2°C at planetary level), there will be important redistribution effects between sectors and between countries. The impact will be more negative in southern Europe than in northern Europe. Primary sectors such as agriculture, forestry and fisheries will be affected more severely than others. The attraction of tourist destinations will change. Cooler regions will become more appealing while already warm regions could become torrid. Ski resorts at low and medium altitude could be affected by reduced snow cover. Since numerous local economies rely on tourism, the impact on employment could be significant at local level.

The likelihood of the development of extreme weather conditions will affect the insurance industry, which will be forced to pass on the rising cost of damages to other economic sectors. The increase in compensation claims will put new pressure on insurance companies. It is not believed that the solvency of the sector as a whole will be threatened by climate change, but significant structural changes should be expected, to which small companies will be particularly vulnerable.

Climate change will interact with other critical problems such as water shortages, the loss of biodiversity, the use of energy and so on, and will consequently have a strong influence on our work, production and consumption practices. The increased scarcity of these resources and their higher cost will certainly have an impact on the sectors most exposed to competition.

If one considers the overall impact on the economy and employment, the models predict a relatively minimal total economic impact for the short term which, on the assumption of modest and gradual warming, could even prove to be slightly positive in Europe. Taken literally, this could prompt the public authorities and businesses to neglect the social issue. All parties involved must be energetically alerted to the harmful consequences of such an attitude.

On the other hand, more pronounced climate change is expected to be far more harmful. In recent years, a number of signs have shown that the climate may well not evolve slowly and progressively as has often been supposed. In that case, without rapid attenuation and adaptation measures, climate change will have a significant impact on economic activity and employment, with critical consequences in the latter half of the century. For example, the aridification or even desertification of certain areas of southern Europe would necessitate a rapid redefinition of their agriculture policies. In the longer term, climate change could lead to a complete overhaul of spatial planning in Europe. That is why it clearly emerges that more comprehensive territorial and sectoral analyses are needed at present to identify the type and scope of employment that is particularly vulnerable to the impacts of climate change, based on different global warming scenarios, and to provide input for the development of appropriate adaptation policies.

Sectoral effects of measures to reduce CO_2 emissions

The second chapter of the study looks into the potential repercussions on employment of a reduction of some 30% to 50% of CO_2 emissions by 2030, in four key sectors of the European economy: energy-intensive industries (iron and steel, cement), transport, energy production and building/construction.

Energy-intensive industries

The study clearly demonstrates that the European Union's climate policy for the coming decade could have significantly negative social consequences if appropriate steps are not taken now. The iron and steel industry, which is already engaged in a process of relocating outside the EU, could lose some 50,000 jobs out of a total of 350,000 for the EU-25 as a whole. Even if there should prove to be few formal relocations, these could nonetheless take the form of an absence of new investments in Europe ("freeze on investments"). On top of such relocations would come shifts in carbon emissions to countries not applying equivalent CO_2 regulations. Let's be quite clear: the idea is not to conclude that European climate policy has to be challenged; it is to note that these industries deserve specific reflection and a coherent strategy. Indeed, while it exists, the risk of relocations and freezes on investments in Europe remain connected to the fact that the sector is not putting enough effort into research and development. This risk could be lessened by mobilizing the enterprises concerned and putting into place, in parallel with binding measures to combat the greenhouse effect, an industrial policy that combines public aid for research and development programmes, training programmes and a tax on imports not covered by climate change regulations. What is more, it is important to note that the EU's drive to reduce greenhouse gas emissions cannot continue to be built primarily on industry and the energy production sector.

Transport

The transport sector is seen as a difficult one as far as combating climate change is concerned, due to the strong trend growth in its CO_2 emissions and its considerable weight in the European economy and employment. The study estimates at around 15 million the number of jobs related directly and indirectly to transport in the EU 25, i.e. more than 7% of European employment, largely in road transport. Yet the study shows that it is possible to stabilize transport emissions in 2030, with reference to 1990, while creating 20% more jobs overall compared to the reference scenario (BAU), without additional climate change policies. By reducing the volume of traffic of the order of 10% and creating more balance through greater use of rail and public transport, the number of direct and indirect jobs in rail and public transport (tramway, bus, underground, bicycles) would be multiplied fourfold compared to the reference scenario. In contrast, the employment dynamic in the road transport of freight, while still positive, would subside by some 50% compared to the reference scenario. Employment in the automotive sector, moreover, could show a decline of the order of 60% compared to the reference scenario, with numbers employed remaining stable for the period as a whole (2000 to 2030), notably under the impact of the increase in added value related to the dissemination of clean technologies, which could give the European industry a significant technological lead.

Electricity generation

The electricity generation sector, which has undergone major restructuring initiatives over the past decade, resulting in a regular reduction of its staff numbers, will experience profound changes in terms of employment in the coming decades as it adapts to the necessities of combating climate change. A distinction should be made between jobs created directly by the operation and maintenance of power plants, and those created indirectly by investments – the manufacture of equipment and the construction and installation of power plants. The reduction of demand for energy, a priority measure of EU climate policy, should have automatic repercussions on direct employment. A reduction in electricity consumption of some 16% compared to the reference scenario could, in the worst-case scenario, cause the loss of around 20% of direct jobs. Within this overall trend, jobs related directly to renewable energy would fare well, growing by around 50%. Jobs in gas and nuclear energy would remain stable or progress, depending on the scenario considered. The coal sector would lose 50% of its jobs compared to the reference scenario.

If jobs generated indirectly are considered, all sectors are driven by a growth dynamic of around 23%, superior to the level seen in the reference scenario.

For the turn-on stability period of the new electricity generating sectors, the combined effect of the two dynamics is positive because the erosion of direct employment is more than offset by gains in the capital goods industry. Given the long useful life of such equipment, however, job losses are not likely to be offset on a sustainable basis.

Two unknowns remain and may considerably impact on these results. On the one hand, our evaluations underestimate the jobs that could be sustainably created in the electricity sector through the provision of energy services to meet consumers' growing energy efficiency requirements. On the other, it is very difficult to predict the impact on the maintenance of jobs in the coal sector of a massive deployment of carbon capture and storage technologies in the 2020s.

Be that as it may, it is important to note that the net impact of energy savings on employment would be positive. The jobs lost in the coal sector would be largely compensated for by employment gains resulting, on the one hand, from the options that allow energy savings, given the highly capitalistic and low labour intensiveness of the energy production sector, and on the other, from the redistribution of savings on the energy bills of businesses and households. Such jobs are also harder to relocate and are created mainly in small local companies.

Building/Construction

The building and construction sector constitutes an important pool of potential employment resulting from measures to prevent climate change. Thermal renovation of existing buildings, in particular older housing, is an option extremely intensive in direct employment, mostly non-relocatable because connected to a territory or to regional or national markets. The direct jobs created are of relatively low qualification level. However, the building and public works sector will have to take up the challenge of training its workers in "sustainable building" and the sector is not reputed for being highly innovative or dynamic on worker training and qualification. The extension of the scope of the directive on energy performance of buildings would create a further 30,000 to 90,000 man-years in the EU 15 compared to the reference scenario, on top of which will come another 90,000 man-years in the new Member States. The job gains compared to the reference scenario are in excess of one million man-years in the case of works corresponding to high energy quality (50 kWh/m2), or 10% of European employment in the sector. The launch of an initiative on the thermal renovation of social housing and subsidized housing would have a particularly important leverage effect because it would result in action on a lot of housing and a lot of emissions in a brief period of time. What is more, such activities are likely to create additional social benefits: the integration of the long-term jobless or socially-impaired persons, easing of the energy bill and improved living conditions for less favoured households.

Overall impact, quantitative and qualitative, on employment

Based on sectoral results, two conclusions of a general nature may be made. First, the findings of this study do not dispute those of research using macro-economic modelling, which concludes that there will be a limited positive impact on employment from climate change, provided appropriate economic policies are put in place. According to an estimate of the employment content of the emissions reduction options, the overall balance of jobs in the branches that will expand and in those where activity will be reduced does not appear negative and may even be positive. Compared to the trend scenario, the overall net gain in employment for the sectors covered by the study would be of the order of 1.5%.

Second, the large-scale redistribution of jobs that will result from the implementation of climate policies will occur within rather than between sectors. At first sight, that seems to be a positive element, because it is considered to be easier for workers to change companies within the same sector than to find work in a different sector. Job changes within a sector can, for example, mean lower retraining costs for workers and shorter search periods. On the other hand, job movements are likely to take place in all sectors. Jobs will be created in companies that can take advantage of opportunities created by climate policies and jobs will be lost in companies that cannot adapt. That should make it harder for policy makers and the social partners to identify threatened jobs and new jobs.

Of course, the changes brought on by climate policies are closely interwoven with those resulting from other dynamics at work in the different sectors, in particular globalisation and technical progress. This suggests that climate change must be integrated into all European Union policies, in particular industrial, trade and employment policy.

Over and above the quantitative aspects, climate policies should contribute to rising demand for increasingly educated and qualified workers, not only in terms of technological developments, but also in innovation. This is a general evolution of the economy and is also valid for the process of combating climate change. The integration of new low-carbon information and communication technologies (design and management of control systems in building and transport) and research into new products and services (new composite materials in wind energy) will require high-level qualifications.

The potentially "winning" sectors, such as building, electrical equipment manufacturing, renewable energy, logistics and intermodal transport, will have to evolve positively at the social and wage levels in order to create attractive jobs for job seekers. Indeed, there is a risk — which is not limited to climate policies but is also valid for the information and communication technologies sector — that jobs developed in newly created companies may be perceived by workers as less well paid and offering less secure working conditions than jobs in well established branches, in particular the historic operators of the electricity sector. That is the case for certain companies in the renewable energy or energy services sector.

On the other hand, the new service occupations can offer better working conditions than certain difficult manual trades. For example, jobs related to energy audits could offer redeployment possibilities for older workers in the construction sector.

The choice between these options can depend on the results of social dialogue which, by identifying opportunities and encouraging vocational transitions, can strengthen the positive aspects of the necessary changes.

Policy-making recommendations

This study points out the policy options most effective for earning the double dividend of combating climate change and creating jobs. It also recommends the mechanisms that should be developed to accompany the changes needed and to ensure that workers are active players in such change.

Climate policies must be clear, certain and foreseeable, to result in investments in the right direction. Business investments will indeed be a vital component of preventing climate change. They will create many of the jobs predicted in the study. Over and above setting targets for reducing $C0_2$ emissions, as was done at the European Council of March 2007 for 2020, the study demonstrates the importance and urgency of introducing binding implementing measures in a few key sectors, among which transport, housing and the tertiary sector. The EU must actively promote the inclusion of the industrialized nations not presently parties to the Kyoto Protocol and the emerging countries in a system to combat climate change to ensure fair competition conditions on global markets, crucial for keeping a strong industrial base and sustainable jobs in Europe.

Knowledge of the potential repercussions on employment of climate change and prevention policies is lacking and additional research is needed at an early date. A stepped-up emissions reduction effort in the coming years will certainly make the employment issue a key element of the European Union's climate policies. It is therefore necessary to evaluate climate policies and measures systematically from the standpoint of their potential impact on jobs.

While employment is not the primary objective of policies to counter climate change, the employment situation in the European Union, with 19 million jobless, requires the public powers to make the most of synergy between climate protection and the development of quality jobs.

Substantial and fitting public resources must be mobilized to achieve the wide range of public and private investments required: programmes for thermal renovation of older housing, plans for the development of renewable energy and combined heat and power systems and the development of infrastructures for alternatives to road transport, for public transport and for "soft" mobility. Investments in research and development need to be enhanced and increased by allocating resources for innovation that can result in the technological, organisational and societal breakthroughs required. Economic instruments (carbon market and carbon or energy tax) must be used because they will make for a reduction in emissions at the lowest cost. They must nevertheless be matched with measures attenuating the impact on low-income households and energy-intensive sectors exposed to international competition (cement works, aluminium, lime, pulp, glass, ceramics, etc.). For these sectors, the study recommends the development, in parallel with the emissions trading scheme, of proactive industrial policies by the national and European public authorities combining public aid with research and development, vocational training programmes, cross-border adjustment mechanisms, and the involvement of the social partners, with the aim of transforming into a competitive advantage the carbon constraint that will increasingly weigh on the companies in these sectors in the future.

If not anticipated and dealt with appropriately, the questions of occupational transitions and training – largely underestimated by the majority of professionals concerned – can represent a significant roadblock to sectoral transformation required by European emissions reduction targets. The study recommends the development of social accompaniment measures to reassure workers and enable them to adapt to the structural changes in skills associated with the process of reducing greenhouse gas emissions. The idea would be to use social negotiations to mobilize a process and tools for "forward-looking jobs and skills management", by associating tools allowing an assessment of the foreseeable qualitative and quantitative evolution of employment, training possibilities corresponding to the evolution of skills in demand on the labour market and income support measures during possible periods of unemployment. In this context, worker mobility required to some extent by climate change prevention policies will have to be based on guarantees of continuity in workers' rights.

Workers' representatives must become players in and not mere spectators to the strategy orientations developed and implemented to control emissions. It is important to improve training and information for economic and social actors, in particular trade union and employers' organisations, on the stakes of climate change. Social dialogue and collective bargaining instruments adapted to the stakes of climate change should be widely developed. The study recommends the creation of a European observatory for economic and social change related to climate change. It also recommends the opening of a tripartite European dialogue (employers, unions and public authorities) on the implementation of adaptation and prevention policies. Dialogue should exist at every level (sectoral, intersectoral, European sectoral), taking as its model the round tables on implementation of the Kyoto Protocol existing in Spain. Their experience clearly shows that there is no obstacle in principle — on the contrary — to greater involvement by the social partners in these matters. Finally, new rights should be granted to workers' representatives, to ensure that they are informed, consulted and allowed to participate in decisions relating to climate change. These rights, which already exist in a number of Member States, must be extended to all European Union countries and to European works councils.

Further research on social policies to accompany climate change measures would certainly be useful, in particular investigations into tools and approaches that have proven their effectiveness in practice. Case studies of economic and occupational transitions that have made it possible to cope with the challenges of climate change, at business or sector level, could provide valuable information on how such policies can shore up climate change policies. Such research could be focused on the following sectors: agriculture and tourism to deal with aspects related to adaptation, and industry (iron and steel, vehicle manufacturing, renewable equipment manufacturing, construction of electricity installations) and transport (road transport of goods, urban public transport) to address aspects related to the mitigation of climate change.

Annex

Description of the scenarios

	BAU/PRIMES	WI/WWF	EEA-Nuclear
Scenario Model & Source	BAU scenario 2030, compared to 1990. Mantzos et al. 2003 (PRIMES), completed by Wuppertal Institute	"Policies & Measures" scenario 2020, compared to 1990. Lechtenböhmer et al. 2005 on behalf of WWF	'Nuclear Accelerated' variant of EEA LCEP scenario 2030, compared to 1990. EEA 2005.
Comparison	**Here: 2000 -> 2020**	**Here: 2000 -> 2020**	**Here: 2000 -> 2030**
Policies & Measures	Continuing policies & measures; no specific emphasis on climate and energy policies	Active climate protection strategy: energy efficiency becomes top priority; stronger emissions trading scheme; increased market penetration of renewables and co-generation; compliance with on-going nuclear phase-out / no new nuclear power plants; particular emphasis on transport sector; ecological tax and subsidy reform	Climate protection strategy: improvements in energy efficiency most important in the short to medium run, further changes in the fuel mix more important in the long run; intensified emissions trading scheme; new nuclear power plants and re-evaluation of declared nuclear phase-out policies; targets for renewables; subsidy reform; increase in R&D; awareness-rising
Technology & Technology Development	To a wide extent, installation of practically proven technology. Efficiency of thermal power plants increases from 37% to 47%.	To a wide extent, installation of practically proven technology. Efficiency of thermal power plants increases from 37% to 49%.	In particular, 40 to 50 new nuclear power plants, e.g. EPR or AP. Efficiency of thermal power plants increases from 37% to 49.5%.
Energy Intensity			(base year: 1990)
Industry	- 1.6%/year	- 2.7%/year	- 1.8%/year
Residential	- 1.4%/year	- 2.6%/year	- 1.8%/year
Tertiary	- 1.4%/year	- 2.7%/year	- 1.6%/year
Transport	- 0.9%/year	- 2.1%/year	- 1.2%/year

Renewables	+ 2.08%/year (to 7.9%)	+ 4.95%/year (to 21.8%)	+ 3.0%/year (to 12.5%)
Electricity Mix			
Total	+ 1.6%/year (2,875 -> 3,950 TWh)	+ 0.7%/year (2,875 -> 3,301 TWh)	+ 1.3%/year (2,898 -> 4,271 TWh)
Nuclear	32.1% -> 21.1% (922 TWh -> 834 TWh)	32.0% -> 24.1% (922 TWh -> 795 TWh)	31.8% -> 30% (922 TWh -> 1,281 TWh)
RES	13.5% -> 16.6%	13.5% -> 38.4%	14.6% -> 27%
Thermal plants	56.2% -> 64.8%	55.6% -> 50.3%	
Co-generation	*12.6% -> 15.0%*	*14.6%* -> 23.5%*	*12.6% -> 17%*
Transport			
Travel in km per capita	+ 1.8%/year	+ 1.6%/year	
Share of rail and public road passenger transport	- 1.2%/year (15.7% -> 12.3%)	- 0.0%/year (15.7% -> 15.7%)	No significant shift in transport modes; stable share of rail and public road transport.
Freight activity per unit of GDP	- 0.2%/year	- 0.5%/year	
Energy & Emissions			
Final energy	+ 1.12%/year	- 0.11%/year	+ 0.61%/year
Primary energy	+ 0.70%/year	- 0.19%/year	+ 0.42%/year
GHG emissions	+ 0.31%/year	- 1.73%/year	
CO_2 emissions	+ 0.44%/year	- 1.78%/year	- 0.42%/year
Economy			
GDP			
Population	+ 2.4%/year	+ 2.4%/year	+ 2.4%/year (?)
	+ 0.1%/year	+ 0.1%/year	+ 0.1%/year (?)
Investment	Total costs of investment in electricity and heat generation and in transmission increase by 1.3%/year up to 91 billion Euro in 2030.	High, but cost-effective investment in energy efficiency. Doubling of investment in renewables, investment in CHP increased by 66%, and thermal power plant investment cut by roughly 50% compared to BAU.	Total costs of investment in electricity and heat generation and in transmission increase by 1.6%/year up to 97 billion Euro in 2030.
Imported energy	+ 1.8%/year	- 0.2%/year	+ 1.1%/year
Total costs of energy imports**	+ 2.0% to + 2.4%/year	+ 0.0% to + 0.5%/year	Significant increase in costs of energy imported
Import dependency	+ 1.10%/year (to 70%)	+ 0.03%/year (to 56%)	+ 0.68%/year (to 57.8%) *(not including uranium)*

Evaluation & Conclusions	Climate protection targets not met. High 'vulnerability' of energy system due to high import dependency. No additional efforts needed.	Climate protection targets met. Domestic investment strategy reduces 'vulnerability'. Largely cost-effective on a macro-economic level. High effort needed by different relevant actors, particularly in the field of energy efficiency on the demand-side.	Climate protection targets only met with huge amount of emission reductions to be achieved outside Europe. Very ambitious target of 40 to 50 new nuclear power plants by 2030. Price-driven equilibrium model leads to paradox results: climate protection targets only met at high costs up to 65 Euro/t CO_2 in 2030 although cost-effective reduction potentials exist.

* In Mantzos et al. 2003, there are only limited information on co-generation plants. The Wuppertal Institute has analysed a higher share of CHP in the electricity market.
** Rough own estimate by Wuppertal Institute, 2006, based on forecasts for prices of imported energy from the PRIMES model and from EWI/PROGNOS 2005, with the rough assumption that costs of uranium are about 5% of production costs of nuclear electricity.

Bibliography of the 1st part

- Adams R.M., Hurd B.H., Lenhart S., Leary N., "Effects of Global Climate Change on Agriculture: an Interpretative Review", *Climate Research*, vol. 11, 1998, pp.19-30.
- Agnew M.D., Palutikof J.P., "Climate Impacts on the Demand for Tourism", in *Proceedings of the First International Workshop on Climate, Tourism and Recreation*, International Society of Biometeorology, Porto Carras, 5-10 October 2001, pp.41-50.
- Aguiar R., « Energy » , chapitre 9, in *Climate Change in Portugal, Scenarios, Impacts and Adaptations Measures*, Projet Siam, Gradiva Publicações, Lisboa, 2002.
- Arnell N., Hulme M., « Implications of Climate Change for Large Dams and their Management » , *Thematic Review,* II.2, préparée en tant que contribution à la World Commission of Dams (WCD), Cape Town, 2000, disponible sur Internet à l'adresse : http://www.dams.org/docs/kbase/thematic/tr22pt4.pdf, consulté le 28 mars 2006.
- Association of British Insurers (ABI), "Financial Risks of Climate Change", 2005, disponible sur Internet à l'adresse : http://www.abi.org.uk/climatechange, consulté le 30 avril 2007.
- Bergström S., Andréasson J., Belgring S., Carlsson B., Graham L.P., Jónsdóttir J.F., Engeland K., Turunen M.A., Vehviläinen B., Førland E.J., « Climate Change Impacts on Hydropower in the Nordic Countries » , préparé pour le projet Climate, Water and Energy (CWE), Reykjavík, 2003, disponible sur Internet à l'adresse : http://www.os.is/cwefiles/downloads/hydro/CWE-hydro-report_030522low.pdf, consulté le 29 mars 2006.
- Berrittella M., Bigano A., Roson R., Tol R.S.J., « A General Equilibrium Analysis of Climate Change Impacts on Tourism » , *Tourism Management*, 27, 2006, pp.913-924.
- Bigano A., Goria A., Hamilton J., Tol R.S.J., « The Effect of Climate Change and Extreme Weather Events on Tourism » , The Fondazione Eni Enrico Mattei, *Nota di Lavoro,* 30.2005, 2005, disponible sur Internet à l'adresse : http://www.feem.it/Feem/Pub/Publications/WPapers/WP2005-030.htm, consulté le 8 mai 2006.
- Bosello F., Roson R., Tol R.S.J., « Economy-wide Estimates of the Implications of Climate Change: Human Health » , *Ecological Economics*, vol. 58, 2006, pp.579-591.
- Bosello F., Zhang J., « Assessing Climate Change Impacts: Agriculture » , The Fondazione Eni Enrico Mattei, *Note di Lavoro*, 94.2005, 2005, disponible sur Internet à l'adresse : http://www.feem.it/Feem/Pub/Publications/WPapers/WP2005-094.htm, consulté le 7 mars 2006.
- Bosello F., Lazzarin M., Roson R., Tol R.S.J., « Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise » , The Fondazione Eni Enrico Mattei, *Note di Lavoro* 96.2004, 2004, disponible sur Internet à l'adresse : http://www.feem.it/Feem/Pub/Publications/WPapers/WP2004-096.htm, consulté le 2 mars 2006.
- Bovagnet F.-C., « Employment in Hostels and Restaurants in the Enlarged EU Still Growing » , Eurostat, *Statistics in focus*, *Industry, Trade and Services, Population and Social Conditions*, 13/2005, 2005, disponbile sur Internet à l'adresse : http://epp.eurostat.cec.eu.int/cache/ITY_OFFPUB/KS-NP-05-032/EN/KS-NP-05-032-EN.PDF, consulté le 8 mai 2006.
- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), "Expected Impacts of Climate Change and Risk Assessment", German Government, chapitre 6, in *Third Report by the Government*

of the Federal Republic of Germany in Accordance with the Framework Convention of the United Nations, 2001, disponible sur Internet à l'adresse : http://unfccc.int/resource/docs/natc/gernc3.pdf, consulté le 11 avril 2006.

- Cartalis C., Synodinou A., Proedrou M., Tsangrassoulis A., Santamouris M., « Modifications in Energy Demand in Urban Areas as a Result of Climate Changes: an Assessment for the Southeast Mediterranean Region » , *Energy Conservation and Management*, 42, 2001, pp.1647-1656.
- Ciais Ph., Reichstein M., Viovy N., Granier A., Ogée J., Allard V., Aubinet M., Buchmann N., Bernhofer Chr., Carrar A., Chevallier F., De Noblet N., Friend A.D., Friedlingstein P., Grünwald T., Heinesch B., Keronen P., Knohl A., Krinner G., Loustau D., Manca G., Matteucci G., Miglietta F., Ourcival J.M., Papale D., Pilegaard K., Rambal S., Seufert G., Soussana J.F., Sanz M.J., Schulze E.D., Vesala T., Valentini R., « Europe-wide Reduction in Primary Productivity Caused by the Heat and Drought in 2003 » , *Nature*, vol. 437, 2005, pp.529-533.
- Clark P.U., Pisias N.G, Stocker T.F., Weaver A.J., "The Role of the Thermohaline Circulation in Abrupt Climate Change", *Nature*, vol. 415, 2002, pp.863-869.
- Clausen N.-E., Barthelmie R., Batchvarova E., Gryning S.-E., Pryor S., Tarp-Johansen N.J., Holttinen H., Ólafsson H., Lundsager P., Tammelin B., Bergström H., « Impact from Climate Change on the Wind Energy Potential in the Nordic Region » , présenté à la *2004 European Wind Energy Conference*, Londres, 22-25 novembre 2004, disponible sur Internet à l'adresse : http://www.os.is/cefiles/wind/EWEC_london_2004_paper_final.pdf, consulté le 30 mars 2006.
- Comité européen des assurances (CEA), *Climate Change and Natural Events, Insurers Contribute to Face the Challenges*, 2006, non publié.
- Crichton D., « Insurance and Climate Change » , *Conference on Climate Change, Extreme Events, and Coastal Cities: Houston and London*, Houston, Texas, 9 février 2005, disponible sur Internet à l'adresse : http://www.benfieldhrc.org/climate_change/insurance_and %20climate_change.pdf, consulté le 17 mai 2006.
- Darwin R., Tsigas M., Lewandrowski J., Raneses A. 1995, 'World Agriculture and Climate Change, Economic Adaptations', United States Department of Agriculture, *Agricultural Economic Report*, Number 703, http://www.ers.usda.gov/Publications/aer703/, viewed 7 March 2006.
- Darwin R.F., Tol R.S.J., "Estimates of the Economic Effects of Sea Level Rise", *Environmental and Resource Economics*, 19, 2001, pp.113-129.
- Deke O., Hooss K.G., Kasten Ch., Klepper G., Springer K., « Economic Impact of Climate Change: Simulations with a Regionalized Climate-Economy Model » , *Kiel Working Paper,* n° 1065, 2001, Kiel Institute of World Economics, disponible sur Internet à l'adresse : http://ideas.repec.org/p/kie/kieliw/1065.html, consulté le 22 mars 2006.
- Díaz Jiménez J., Linares Gil C., García Herrera R., « Impacto de las temperaturas extremas en la salud pública: futuras actuaciones » , *Revista Española de Salud Pública*, vol. 79, n° 2, 2005, pp.145-157.
- Dlugolecki A., « Climate Change and the Financial Services Industry » , *The Insurance Economics*, n° 43, 2001, International Association for the Study of Insurance Economics, Genève.
- Drinkwater K.F., "The Response of Atlantic Cod to Future Climate Change", *ICES Journal of Marine Sciences*, 62, 2005, pp.1327-1337.
- Easterling W., Apps M., « Assessing the Consequences of Climate Change for Food and Forest Resources: a View from the IPCC » , *Climatic Change*, 70, 2005, pp.165-189.
- Elsasser H., Bürki R., « Climate Change as a Threat to Tourism in the Alps » , *Climate Research*, vol. 20, 2002, pp.253-257.

- Engelhard G.H., Heino M., « Climate Change and Condition of Herring Explain Long-Term Trends in Extent of Skipped Reproduction » , International Institute for Applied Systems Analysis (IIASA), *Interim Report*, IR-06-008, 2006, disponible sur Internet à l'adresse : www.iiasa.ac.at/Admin/PUB/Documents/IR-06-008.pdf, consulté le 27 novembre 2006.
- Commission européenne (EU), "Vulnerability Assessment, Climate Change Impacts and Adaptation Measures", chapitre 5, in *Fourth National Communication from the European Community under the UN Framework Convention on Climate Change (UNFCCC)*, 2006, disponible sur Internet à l'adresse : http://unfccc.int/resource/docs/natc/eunce4add.pdf, consulté le 3 avril 2006.
- European Environment Agency (EEA), "Climate Change and River Flooding in Europe", *EEA briefing,* 2005/01, 2005, disponible sur Internet à l'adresse : http://reports.eea.europa.eu/briefing_2005_1/en/briefing_1_2005.pdf, consulté le 24 mai 2006.
- European Environmental Agency (EEA), "Impacts of Europe's Changing Climate", *EEA Report*, n° 2/2004, 2004, disponible sur Internet à l'adresse : http://reports.eea.eu.int/climate_report_2_2004/en/impacts_of_europes_changing_climate.pdf, consulté le 20 mars 2006.
- European Environmental Agency (EEA), « Mapping the Impacts of Recent Natural Disasters and Technological Accidents in Europe » , *Environmental issue report*, n° 35, 2003, disponible sur Internet à l'adresse : http://reports.eea.europa.eu/environmental_issue_report_2004_35/en/accidents_032004.pdf, consulté le 29 décembre 2006.
- Flechsig M., Gerlinger K., Herrmann N., Klein R.J.T., Schneider M. Sterr H., Schellnhuber H.-J., « Weather Impacts on Natural, Social and Economic Systems (WISE), German Report » , Postdam Institute for Climate Impact Research (PIK), *Report,* n° 59, 2000, disponible sur Internet à l'adresse : http://www.pik-potsdam.de/pik_web/publications/pik_reports/reports/reports/pr.59/pr59.pdf, consulté le 1er mai 2006.
- Friends of the Earth (FoEE), *How the European Union responds to the global threat of climate change*, Bruxelles, 2005.
- Garcia C., Gil L., Montero G., « Impactos sobre el sector forestal » , chapitre 9, in Moreno Rodríguez J.M. (coord.), *Evaluación Preliminar de los Impactos en España por Efecto del Cambio Climático*, Ministerio del Medio Ambiente, Madrid, 2005.
- Giannakopoulos Ch., Psiloglou B.E., « Trends in Energy Load Demand for Athens, Greece: Weather and Non-weather Related Factors » , *Climate Research*, vol. 31, 2006, pp.97-108.
- Good P., Bärring L., Giannakopoulos C., Holt T., Palutikof J., « Non-linear Regional Relationships Between Climate Extremes and Annual Mean Temperatures in Model Projections for 1961-2099 over Europe » , *Climate Research*, vol. 31, 2006, pp.19-34.
- Guy Carpenter & Company Ltd., « Windstrom Erwin/Gudrun, January 2005 » , *Special Practice Briefing*, issue n° 2, 2005, disponible sur Internet à l'adresse : http://www.dmi.dk/dmi/8januarstormguycarprapport.pdf, consulté le 17 mars 2006.
- Hamilton J.M., Maddison D.J., Tol R.S.J., « Climate Change and International Tourism: A Simulation Study » , *Global Environmental Change*, 15, 2005, pp.253-266.
- Hansen J., Sato M., Ruedy R., Lo K., Lea D.W., Medina-Elizade M., « Global Temperature Change » , *Proceedings of the National Academy of Sciences of the United States of America*, vol. 103, n° 39, 2006, pp.14288-14293.
- Hulme M., Barrow E.M., Arnell N.W., Harrison P.A., Johns T.C., Downing T.E., « Relative Impacts of Human-induced Climate Change and Natural Climate Variability » , *Nature*, vol. 397, 1999, pp.688-691.

- Intergovernmental Panel on Climate Change (IPCC) 2001a, *Climate change 2001: The Scientific Basis, Third Assessment Report*, Cambridge University Press, Cambridge, UK.
- Intergovernmental Panel on Climate Change (IPCC) 2001b, *Climate change 2001: Impacts, Adaptations and Vulnerability, Third Assessment Report*, Cambridge University Press, Cambridge, UK.
- Jacob H.B. 2005, 'Folgen, Massnahmen und Kosten des Klimawandels für Obstbau in Hessen', Im Rahmen des Integrierten Klimaschutzprogramms Hessen 2012 Baustein II, http://www.hlug.de/medien/luft/inklim/dokumente/endberichte/obstbau.pdf, viewed 13 July 2006.
- Jouhette S., Romans F. 2005, 'EU Labour Force Survey, Principal results 2004', Eurostat, *Statistics in focus*, Population and social conditions, 9/2005, http://www.eu-datashop.de/en/downloads/sif/nk_05_09.pdf, viewed 25 July 2006.
- Kemfert C., « Die ökonomischen Kosten des Klimawandels » , Wochenbericht des Deutsches Institut für Wirtschaftsforschung (DIW), 42/04, 2004, disponible sur Internet à l'adresse : http://www.diw-berlin.de/deutsch/produkte/publikationen/wochenberichte/docs/04-42-1.html, consulté le 10 avril 2006.
- Kemfert C., « An Integrated Assessment Model of Economy-Energy-Climate – The Model Wiagem » , *Integrated Assessment*, vol. 3, n° 4, 2002, pp.281-298.
- Kennedy D., Hanson B., « Ice and History » , *Science*, vol. 311, 2006, p.1673.
- Kerr R.A., "A Worrying Trend of Less Ice, Higher Seas", *Science*, vol. 311, 2006, pp.1698-1701.
- Klinedinst P.L., Wilhite D.A., Leroy Hahn G., Hubbard K.G., « The Potential Effects of Climate Change on Summer Season Dairy Cattle Milk Production and Reproduction » , *Climatic Change*, 23, 1993, pp.21-36.
- Koenig U., Abegg B., « Impacts of Climate Change on Winter Tourism in the Swiss Alps » , *Journal of Sustainable Tourism*, vol. 5, n° 1, 1997, pp.47-58.
- Kundzewicz Z.W., Radziejewski M., Pinskwar I., « Precipitation extremes in the changing climate of Europe » , *Climate Research*, vol. 31, 2006, pp.51-58.
- van Lieshout M., Kovats R.S., Livermore M.T.J., Martens P., « Climate Change and Malaria: Analysis of the SRES Climate and Socio-economic Scenarios » , *Global Environmental Change*, 14, 2004, pp.87-99.
- Link P.M., Tol. R.S.J., « Possible Economic Impacts of a Shutdown of the Thermohaline Circulation: an Application of FUND » , *Portuguese Economic Journal*, 3, 2004, pp.99-114.
- Long S.P., Ainsworth E.A., Leakey A.D.B., Nösberger J., Ort D.R., « Food for Thought: Lower-than-Expected Crop Yield Stimulation with Rising CO_2 Concentrations » , *Science*, vol. 312, 2006, pp.1918-1921.
- López Zafra J.M., Sánchez de Tembleque L.J., Meneu Ferre V., « Impactos sobre el sector energético » , chapitre 13, in Moreno Rodríguez J.M. (coord.), *Evaluación Preliminar de los Impactos en España por Efecto del Cambio Climático*, Ministerio del Medio Ambiente, Madrid, 2005.
- Lundmark L., Jansson B., Pahekevich A., *Report on Forestry Sector Vulnerability and Baseline Scenarios*, Balance project, Second Periodic Report, 2005, disponible sur Internet à l'adresse : http://balance1.uni-muenster.de/balance_data/exchange/D %203_3.pdf, consulté le 30 avril 2006.
- Nakicenovic N., Swart R., *Emissions Scenarios, A Special Report of the Working Group III of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, 2000.
- Martinez-Alier J., Munda G., O'Neill J., « Weak Comparability of Values as a Foundation for Ecological Economics » , *Ecological Economics*, 26, 1998, pp.277-286.

- Martrat B., Grimalt J.O., Lopez-Martinez C., Cacho I., Sierro F.J., Abel Flores J., Zahn R., Canals M., Curtis J.H., Hdell D.A., « Abrupt Temperature Changes in the Western Mediterranean over the Past 250,000 Years » , *Science*, vol. 306, 2004, pp.1762-1765.
- McEvoy D., Handley J.F., Cavan G., Aylen J., Lindley S., McMorrow J., Glynn S., *Climate Change and the Visitor Economy: the challenges and opportunities for England's Northwest,* Sustainability Northwest (Manchester) and UKCIP (Oxford), 2006, disponible sur Internet à l'adresse : http://www.snw.org.uk/tourism/downloads/CCVE_Challenges_And_Opportunities.pdf, consulté le 27 novembre 2006.
- McGranahan G., Balk D., Anderson B., « Low Coastal Zone Settlements » , *Tiempo*, Issue 59, 2006, pp.23-26.
- McMichael A.J., Woodruff R.E., Hales S., « Climate Change and Human Health: Present and Future Risks » , *The Lancet*, vol. 367, 2006, pp.859-869.
- Mendelsohn R., Dinar A., Williams L., « The Distributional Impact of Climate Change on Rich and Poor Countries » , *Environment and Development Economics*, 11, 2006, pp.159-178.
- Mendenlsohn R., Morrison W., Schlesinger M.E., Andronova N.G., « Country-specific Market Impacts of Climate Change » , *Climatic Change*, 45, 2000, pp.553-569.
- Milbank N., « Building Design and Use, Response to Climate Change » , *Architects Journal*, 89, 1989, pp.59-63.
- Mills E., « Insurance in a Climate of Change » , *Science*, vol. 309, 2005, pp.1040-1044.
- Milly P.C.D., Wetherald R.T., Dunne K.A., Delworth T.L., "Increasing Risk of Great Floods in a Changing Climate", *Nature*, vol. 415, 2002, pp.514-517.
- Ministerio de Medio Ambiente, "Evaluación de la vulnerabilidad, efectos del cambio climático y medidas de adaptación", Spanish Government, in *Cuarta comunicación nacional de España, Convención Marco de las Naciones Unidas sobre el Cambio Climático*, 2006, disponible sur Internet à l'adresse : http://unfccc.int/resource/docs/natc/spanc4.pdf, consulté le 11 avril 2006.
- Ministry of Sustainable Development 2005, 'Vulnerability assessment, climate-change impacts and adaptation', Swedish Government, chapter 6 in *Sweden's fourth national communication on climate change under the United Nations Framework Convention on Climate Change (UNFCCC)*, http://unfccc.int/resource/docs/natc/swenc4.pdf, viewed 6 April 2006.
- Modelling the Impacts of Climate Extremes (MICE), "Summary of Final Report", 2005, disponible sur Internet à l'adresse : http://www.cru.uea.ac.uk/projects/mice/FINAL_VERSION_MICE_REPORT.pdf, consulté le 20 avril 2006.
- Moriondo M., Good P., Durao R., Bindi M., Giannakopoulos C., Corte-Real J., « Potential Impact of Climate Change on Fire Risk in the Mediterranean Area » , *Climate Research*, vol. 31, 2006, pp.85-95.
- Mudelsee M., Börngen M., Tetzlaff G., Grünewald U., « No Upward Trends in the Occurrence of Extreme Floods in Central Europe » , *Nature*, vol. 425, 2003, pp.166-169.
- Murray T., « Greenland's Ice on the Scales » , *Nature*, vol. 443, 2006, pp.277 - 278.
- Nieto Sainz J., « Cambio climático y Protocolo de Kioto: efectos sobre el empleo, la salud y el medio ambiente » , *Información Comercial Española (ICE)*, n° 822, 2005, pp.25-38.
- Nordhaus W.D., Boyer J., « The Impacts of Climate Change » in *Warming the World, Economic Models of Global Warming*, The MIT Press, Cambridge, Massachusetts, 2000, pp.69-98.

- O'Brien K., Eriksen S., Sygna L., Naess L.O., « Questioning Complacency: Climate Change Impacts, Vulnerability, and Adaptation in Norway » , *Ambio*, vol. 35, n° 2, 2006, pp.50-56.
- Organisation for Economic Co-operation and Development (OECD), *The Benefits of Climate Change Policies*, *Executive Summary*, 2006, disponible sur Internet à l'adresse : http://www.oecd.org/dataoecd/40/33/34090686.pdf, consulté le 6 octobre 2006.
- Olesen J.E., Bindi M., « Consequences of Climate Change for European Agricultural Productivity, Land Used and Policy » , *European Journal of Agronomy*, 16, 2002, pp. 239-262.
- Overpeck J.T., Otto-Bliesner B.L., Miller G.H., Muhs D.R., Alley R.B., Kiehl J.T., "Paleoclimatic Evidence for Future Ice-sheet Instability and Rapid Sea-level Rise", *Science*, vol. 311, 2006, pp.1747-1750.
- Palmer T.N., Räisänene J., « Quantifying the Risk of Extreme Seasonal Precipitation Events in a Changing Climate » , *Nature*, vol. 415, 2002, pp.512-514.
- Parry M.L. (ed.), *Assessment of Potential Effects and Adaptations for Climate Change in Europe. The Europe Acacia Project*, Jackson Environment Institute, University of East Anglia, Norwich, 2000.
- Parry M., Rosenzweig C., Iglesias A., Fischer G., Livermore A., « Climate Change and World Food Security: a New Assessment » , *Global Environmental Change*, 9, 1999, S51-S67.
- Pashkevich A., « Impacts of Climate Change on Major Economic Sectors of the European North » in Lange M.A, Poszig D. (eds.), *Integrated Regional Impact Studies in the European North: Basic Issues, Methodologies and Regional Climate Modelling – II (IRISEN-II)*, Proceedings of an Advanced Study Course at Abisko Scientific Research Station, Sweden, 20 July – 3 August 2002, Centre for Environmental Research, University of Münster, 2004.
- Perry A., « More Heat and Drought – Can Mediterranean Tourism Survive and Prosper? » in *Proceedings of the First International Workshop on Climate, Tourism and Recreation*, International Society of Biometeorology, Porto Carras, 5-10 octobre 2001, pp.35-40.
- Perry A., « Impacts of Climate Change on Tourism in the Mediterranean: Adaptive Responses » , The Fondazione Eni Enrico Mattei, *Nota di Lavoro* 35.2000, 2000, disponible sur Internet à l'adresse : http://www.feem.it/Feem/Pub/Publications/WPapers/WP2000-035.htm, consulté le 6 septembre 2006.
- Piñol J., Terradas J., Lloret F., « Climate Warming, Wildfire Hazard, and Wildfire Occurrence in Coastal Eastern Spain', *Climatic Change*, 38, 1998, pp.345-357.
- Piserra T., Nájera A., Lapieza R., « Impactos sobre el sector del seguro » , chapitre 15, in Moreno Rodríguez J.M. (coord.), *Evaluación Preliminar de los Impactos en España por Efecto del Cambio Climático*, Ministerio del Medio Ambiente, Madrid, 2005.
- Rehdanz K., Hamilton J., « Valuing the Impacts of Climate Change » in Lange M.A, Poszig D. (eds.), *Integrated Regional Impact Studies in the European North: Basic Issues, Methodologies and Regional Climate Modelling – II (IRISEN-II)*, Proceedings of an Advanced Study Course at Abisko Scientific Research Station, Sweden, 20 July – 3 August 2002, Centre for Environmental Research, University of Münster, 2004.
- Rose G.A., "On the distributional responses of North Atlantic fish to climate change", *ICES Journal of Marine Sciences*, 62, 2005, pp.1360-1374.
- Roson R., "Modelling the Economic Impact of Climate Change", *EEE Working Papers Series*, n° 9, 2003, disponible sur Internet à l'adresse : http://www.ictp.trieste.it/~eee/files/WP9 %20- %20Roson.pdf, consulté le 28 mars 2006.
- Salz P. Buisman E., Smit J., de Vos B., "Employment in the Fisheries Sector: Current Situation", European Commission, Final report, FISH/2004/4, 2006, disponible sur Internet à l'adresse :

http://ec.europa.eu/fisheries/publications/studies/employment_study_2006.pdf, consulté le 22 août 2006.

- Sánchez A.B., Dalle M., *Cambio climático, Efectos en el sector agrario,* Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS), 2005, disponible sur Internet à l'adresse : http://www.istas.ccoo.es/descargas/CCAgrario.pdf, consulté le 24 mai 2006.
- Sánchez A.B., Dalle M., *Cambio climático, Efectos sobre el turismo*, Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS), 2005, disponible sur Internet à l'adresse : http://www.istas.ccoo.es/descargas/CCTuris.pdf, consulté le 24 mai 2006.
- Sánchez A.B., Dalle M., *Cambio climático, Efectos sobre los sectores productivos (energético, industrial y otros)*, Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS), 2005, disponible sur Internet à l'adresse : http://www.istas.ccoo.es/descargas/CCSecProd.pdf, consulté le 24 mai 2006.
- Van Schalkwyk M., "Setting Priorities", in *Our Planet*, United Nations Environment Program, vol. 17, n° 2, 2006, pp.8-9.
- Schmidt H.-W., "Tourism in the enlarged European Union", Eurostat, *Statistics in focus*, *Industry, Trade and Services, Population and Social Conditions*, 13/2005, 2005, disponible sur Internet à l'adresse : http://epp.eurostat.cec.eu.int/cache/ITY_OFFPUB/KS-NP-05-013/EN/KS-NP-05-013-EN.PDF, consulté le 8 mai 2006.
- Sohngen B., Mendelsohn R., Sedjo R., "A Global Model of Climate Change Impacts on Timber Markets", *Journal of Agricultural and Resource Economics*, 26(2), 2001, pp.326-343.
- Sousa Reis C., "Fisheries", chapitre 11 in *Climate Change in Portugal, Scenarios, Impacts and Adaptations Measures*, Siam Project, Gradiva – Publicações, Lisboa, 2002.
- Stern N., 'The Impacts of Climate Change on Growth and Development", Part II, *Stern Review on the Economics of Climate Change*, 2006, disponible sur Internet à l'adresse : http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm consulté le 21 novembre 2006.
- Swiss Re, United Nations Development Programme (UNDP), *Climate Change Futures, Health, Ecological and Economic Dimensions*, The Center for Health and the Global Environment, Harvard Medical School, 2005, disponible sur Internet à l'adresse : http://www.climatechangefutures.org/pdf/CCF_Report_Final_10.27.pdf, consulté le 30 mars 2006.
- Tol R.S.J., "Estimates of the Damage Costs of Climate Change, part 1: Benchmark Estimates", *Environmental and Resource Economics*, 21, 2002, pp.47-73.
- Toman M., "Values in the Economics of Climate Change", *Environmental Values*, 15, 2006, pp.365-379.
- Vellinga P., Mills E., "Insurance and other Financial Services", chapitre 8, in *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge university Press, Cambridge, 2001.
- Venäläinen A., Tammelin B., Tuomenvirta H., Jylha K., Koskela J., Turunen M.A., Vehviläinen B., Forsius J., Järvinen P., "The Influence of Climate Change on Energy Producion & Heating Energy Demand in Finland", *Energy & Environment*, vol. 15, n° 1, 2004, pp.93-109.
- Viner D., Agnew M., "Climate Change and Its Impacts on Tourism", rapport élaboré pour WWF-UK, Climatic Research Unit, University of East Angelia, Norwich, 1999, disponible sur Internet à l'adresse : http://www.wwf.org.uk/filelibrary/pdf/tourism_and_cc_full.pdf, consulté le 6 septembre 2006.
- Watkiss P., Downing T., Handley C., Butterfield R., *The Impacts and Costs of Climate Change,* rapport final commandé par la Commission européenne à la DG Environnement, 2005, disponible sur Internet à

l'adresse : http://europa.eu.int/comm/environment/climat/pdf/final_report2.pdf, consulté le 26 juillet 2006.

- WISE (Weather Impacts on Natural, Social and Economic Systems), *Workshop on Economic and Social Impacts of Climate Extremes*, Amsterdam, 14-16 octobre 1999, disponible sur Internet à l'adresse : http://www.cru.uea.ac.uk/cru/projects/wise/workshop/report.pdf, consulté le 19 avril 2006.
- World Health Organization (WHO), "Climate Change and Human Health – Risks and Responses", Résumé, 2003, disponible sur Internet à l'adresse : http://www.who.int/globalchange/climate/en/ccSCREEN.pdf, consulté le 31 mai 2006.
- World Tourism Organisation (WTO), *Tourism Market Trends 2005*, 2005, disponible sur Internet à l'adresse : http://www.world-tourism.org/facts/menu.html, consulté le 26 juillet 2006.
- World Wide Fund for Nature (WWF), *Stormy Europe, the power sector and extreme weather*, PowerSwitch! Campaign, Gland, 2006.
- Worm B., Barbier E. B., Beaumont N., Duffy J.E., Folke C., Halpern B.S., Jackson J.B.C., Lotze H.K., Micheli F., Palumbi S.R., Sala E., Selkoe K.A., Stachowicz J.J., Watson R., "Impacts of Biodiversity Loss on Ocean Ecosystem Services", *Science*, vol. 314, 2006, pp.878-790.

Bibliography of the second part

- OCDE, « Politiques de l'environnement et emploi », in *The Forgotten Benefits of Climate Change Mitigation: Innovation, Technological Leapfrogging, Employment, and Sustainable Development*, OECD ENV/EPOC/GSP(2003)16/FINAL, étude coordonnée par le professeur R. V. Sprenger, IFO, Munich, 1997.
- OCDE, *Economy-wide Employment Impacts Resulting from the Implementation of the Kyoto Protocol: A Simulation Using the NEMESIS Model*, doc ENV/EPOC/WPNEP(2003)5, Paris, 2003.
- Prognos, *Employment Impacts of Climate Change Policies*, Cologne, mars 2001.
- *Fiscalité de l'environnement*, rapport du Conseil d'analyses économiques, 1998.
- Kohlhaase, *Gesamtwirtschaftliche Effekte des ökologischen Steuerreform,* rapport final du Umweltbundesamt, FKZ 204-41-194, DIW, Berlin, 2005.
- Commission européenne, communication « Vaincre le changement climatique planétaire », 2005.
- Commission européenne, communication « Création d'un marché mondial du carbone, rapport en vertu de l'article 30 de la directive 2003/87/CEE », 2006.
- Schelhaase J., *Arbeitspätze durch Klimaschutz,* Prognos, étude pour le compte du Umweltbundesamt, Cologne, 2000.
- Schleich J. *et al.*, *Endogenoous Technological Change and CO_2 Emissions, the Case of Energy-intensive Industries in Germany,* Stuttgart, 2006.
- Institut Bruno Leoni, *Global Insight*, 2003.

Bibliography of the 3rd part

Energy

- ADAS Consulting Ltd, University of Newcastle, *Renewable Energy and Its Impact on Rural Development and Sustainability in the UK*, 2003
- ADEME, *Capture et stockage géologique du CO2 : les perspectives,* François Moisan, directeur de la Stratégie et de la Recherche, 2006
- Bataille C., Galley R., *L'aval du cycle nucléaire. Tome II : Les coûts de production de l'électricité*, Rapport n° 1359, Sénat, 3 février 1999
- Bremerenerie Institut, *Renewable energies — environmental benefits, economic growth and job creation*, Wolfgang Pfaffenberger, Karin Jahn, Martha Djourdjin, 2006
- Bureau fédéral du Plan, *Perspectives énergétiques pour la Belgique à l'horizon 2030,* Dominique Gusbin, Bruno Hoornaert , janvier 2004
- Bureau fédéral du Plan, *Demande maîtrisée d'électricité : Elaboration d'une projection à l'horizon 2020*, D. Gusbin, octobre 2004
- Chris Hewett, Julie Foley, *Employment Creation and Environmental Policy: a literature review - A Report,* Public Policy Research Associates Ltd, commissioned by the Trade Union Sustainable Development Advisory Committee (TUSDAC), octobre 2000
- CNRS / LEPII-EPE (France), RIVM / MNP (Pays-Bas), ICCS-NTUA (Grèce), CES-KUL (Belgique), *Greenhouse Gas Reduction Pathways in the Unfccc Process up to 2025–2003*
- Deloitte, *Energy, Infrastructure and Utilities – 2020 Vision the next generation, Meeting UK power generation objectives in 2020 - a strategic insight*
- DG TREN, *European Energy and Transport, Scenarios on energy efficiency and renewables*, 2006
- DG TREN, *European Energy and Transport Scenarios on Key Drives*, 2004
- DG TREN, *Energy & Transport 2005 : General Data*
- DG TREN, *Energy Stats 2005*
- DLR Institute, *Energy Revolution: A sustainable pathway to a clean energy future for Europe a European energy supply scenario developed on behalf of Greenpeace International*, Wolfram Krewitt- DGEMP, Groupe „Facteur 4", 13 décembre 2005, Paris
- DGEMP, *Étude pour une prospective énergétique concernant la France*, Observatoire de l'énergie et direction générale de l'Énergie et des Matières premières, février 2005
- DTI, *Energy Review – A report*, The energy Challenge, 2006
- DWTMA, *Employment in the Wind Power Industry*, Wind Power Note 2, mars 1996
- ECOFYS, *Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change- Economic Evaluation of Carbon Dioxide and Nitrous Oxide Emission Reductions in Industry in the EU Bottom-up Analysis,* 2001
- ECONOTEC, *Modèle EPM : Analyse prévisionnelle des émissions de gaz à effet de serre en Belgique en 2010,* Rapport Final, 2002
- ECOTEC Research & Consulting Limited, *Renewable Energy Sector in the EU: its Employment and Export Potential – A Final Report to DG Environment -*

- EEA, *Climate change and European low –carbon energy system,* Report n° 1, 2005
- ENDESA, *El protocolo de Kyoto en el marco del diálogo social - Las respuestas de los sectores afectados*, *El Sector Eléctrico*, Fernando Ordóñez Monteagudo, Dirección de Medio Ambiente y Desarrollo Sostenible, ENDESA SA, Jornadas andaluzas sobre las consecuencias sociales y de empleo de las políticas de mitigación del cambio climático, Séville, novembre 2006
- ENERDATA LEPII, *Étude pour une prospective énergétique concernant la France*, Rapport final, décembre 2005, Convention n° 03.2.18.09.07, Observatoire de l'énergie, direction générale de l'Énergie et des Matières premières
- Antoine Bonduelle et Mathias Lefevre, *EOLE ou PLUTON*, rapport commandité par Greenpeace, décembre 2003
- ESD, Greenpeace, *Offshore Wind Onshore jobs – a new industry for Britain*
- EUREC Agency, *FP7 Research Priorities for the Renewable Energy Sector*, 2006
- Eurelectric, *Statitics and propects for the European electrcicity sector – 1980-1990, 2000-2020,* Europrog 2005
- Commission européennes, *Plan d'action dans le domaine de la biomasse*, Communication de la Commission, 2005
- European Commission, *World Energy, Technology and Climate Policy Outlook – WETO 2030- 2003*
- European Commission, *World Energy Outlook H²0– WETO 2050 - 2006*
- Commission européenne, *Pour une Europe de l'énergie propre, sûre et efficace -2003*
- European Commission, *A Vision for Photovoltaic Technology*, Report by the Photovoltaic Technology Research Advisory Council (PV-TRAC), 2005
- European Commission, *European CO2 Capture and Storage*, 2004
- EWA, *Wind Energy – The Facts*, Volume 3, Industry & Employment
- EWI PROGNO, *The trend of energy markets up to the yaer 2030*, Reference Forecast for the Energy Sector Energy, Report IV, 2005
- FONDDRI, *Prospective énergétique à 2050, contrainte carbone et changements structurels*, Patrick Criqui, Silvana Mima, Christophe Rynikiewicz, LEPII-EPE, 2006
- IDDRI, *Scenarios for France nies cop11/mop1 side event*, *Global Challenges Toward Low-Carbon Economy Focus on Country-Specific Scenario Analysis*, Hubert Kieken, décembre 2005
- IEA, *World Energy Outlook 2006*
- IEA, *Energy technology perspectives – Scenarios & strategies to 2050,* 2006
- Institute of Communication and Computer Systems of National Technical University of Athens, *The Economic Effects of EU-Wide Industry-Level Emission Trading to Reduce Greenhouse Gases*; *Results from PRIMES Energy Systems Model,* E3M Lab, Prof. P. Capros, Dr. L. Mant2os, mai 2000
- IZT Institute for Futures Studies and Technology Assessment, *Delphi Report EurEnDel- Technology and Social Visions for Europe's Energy Future a Europe-wide Delphi Study,* 2004
- MIES, Radanne, *Reducing C02 emissions fourfold in France by 2050*, 2004
- Ministère de l'Economie, des finances et de l'industrie, ministère de l'Ecologie et du developpement durable, *The Factor 4 Objective: addressing the Climate Challenge in France - Report from the Working Group on "Achieving a fourfold reduction in greenhouse gas emissions in France by 2050",* chaired by Christian de Boissieu, 2006

- MITRE, *Meeting the Targets & Putting Renewables to work*, Altener Programme
- NEGAWATT, *Scénario négaWatt pour un avenir énergétique sobre, efficace et renouvelable,* 2004
- NJPIRG Law and Policy Center, Dave Algoso , Emily Rusch, *Renewables Work*
- Job Growth, *Renewable Energy Development in the Mid-Atlantic*, Spring 2004
- OCDE, *Le changement climatique et l'emploi*, 2001
- OECD, *Labour/management programme joint meeting of management and trade union experts on climate change and employment,* Paris, 12 octobre 2001
- OECD, *Working Party on National Environmental Policy environment and employment: an assessment*, 2004
- OBSERVER, *Worldwide electricity production from renewable energy sources*, 2005
- Office parlementaire d'évaluation des choix scientifiques et technologiques, Rapport, *Les nouvelles technologies de l'énergie et la séquestration du dioxyde de carbone : aspects scientifiques et techniques,* 2006
- Öko-Institut e.V., *Innovative approaches to the creation of jobs in environmental protection - Summary of the research project*, No 201 14 111 of the UFOPLAN 2001, For the Federal Environmental Protection Agency (Umweltbundesamt), Berlin, juin 2003
- Pfaffenberger, Jahn & Djourdjin, *Case Study Paper : Renewable energies – environmental benefits , economic growth and job creation*, Wolfgang Pfaffenberger, Karin Jahn, Martha Djourdjin, Paper prepared for "Green Roads to Growth Forum", Copenhagen, March 1-2, 2006
- PREDAC, *New jobs in the field of renewable energy and rational use of energy in the European Union*, 2003
- Quirion P., *Calcul du contenu en emplois nationaux, directs et indirects, de la demande adressée aux différentes branches de l'économie française,* note du 8 février 2006
- REN21, *Renewables 2005 Global Status Report*
- SAVE contract XVII/4.1031/D/97-032, *National and Local Employment Impacts of Energy Efficiency Investment Programmes - Final report to the Commission,* avril 2000
- SAVE contract XVII/4.1031/D/97-032, ECN-C--99-060, *Case Studies On Energy Conservation And Employment In The Netherlands, Subsidy on Condensing Boilers*, subsidy on Energy Management Systems and Introduction of an Energy Performance Standard (EPN), P.G. Dougle & R.J. Oosterheert, octobre 2000
- SFEN GR 21, C. Acket, P Bacher, *France : perspectives énergétiques pour 2050*
- Solar Generation, *Solar electricity over one billion people and two million jobs by 2020*, EPIA Greenpeace, septembre 2006
- TEKES, *Developing technology for large-scale production of forest chips Wood Energy Technology Programme 1999–2003*
- TUC, *A Sustainable Energy Policy- TUC response to the Government's Energy Review 2006*
- TUSDAC, *Greening the workplace a report by the TUSDAC unions*, juin 2005
- TUSDAC, *Employment Creation and Environmental Policy: a literature review*, Chris Hewett and Julie Foley, A Report by Public Policy Research Associates Lt Commissioned by the Trade Union Sustainable Development Advisory Committee, octobre 2000
- Umweltbundesamt [Federal Environmental Agency], *Environmental Protection and Employment The link for a worthwhile future*, 1998
- University of California Berkeley, Daniel M. Kammen, Kamal Kapadia, Matthias Fripp, *Putting Renewables to work : how many jobs can the clean energy industry generate,* avril 2004

- VTT Processes Jyviskylii, *Distributed generation for sustainable development — Case Finland*, Research Manager Satu Helynen, 2005
- World Business Council for Sustainable Development, *Pathways to 2050 Energy & climate change*
- World in German Advisory Council, *Transition Towards Sustainable Energy Systems,* 2003
- Wuppertal Institut, *Target 2020 : Policies and measures to reduce Greenhouse gas emission in the EU,* 2005
- Wuppertal Institut, *Long-term scenarios for a sustainable energy future in Germany*
- Research project for the German Umweltbundesamt, UFOPLAN FKZ 200 97 104- 2002 ZEW, *The Impacts of the European Emissions Trading Scheme on Competitiveness and Employment in Europe,* report commissioned by World Wide Fund for Nature (WWF), 2006

Transports

- CATRAM, *Étude sur l'intérêt d'une normalisation des unités de chargement intermodales pour développer le transport combine européen*, 2005
- CNT, *Les dossiers de l'observatoire transports Europe*, « Dossier n°2 : Le fret ferroviaire en Europe », 2001
- Concave Europcar, *Well-to-wheels analysis of future automotive fuels and powertrains in the european context*, 2006
- Conseil national des transports, *L'effet de serre et les transports : les potentialités des permis d'émission négociables,* 2001
- DAEI-SESP, *La demande de transport en 2025, Eléments d'évaluation environnementale*, octobre 2004
- DAEI-SESP, Samarcande, *Le transport léger - Situation et perspectives,* juin 2005
- DG TREN, *European Energy and Transport Scenarios on Key Drives*, 2004
- DG TREN, *Energy & Transport 2005 : General Data*
- DG TREN, *Sustainable Mobility – Results from the transport research programme*, 2001
- DG TREN, *Intermodal Freight Terminals - In search of efficiency to support intermodality growth*, 2006
- DG TREN, *European Energy and Transport – Trends to 2030*, Uptade 2005
- DG TREN, *Energy and transport figures 2005,* "Part 3: Transport"
- ECOTEC, *Less Traffic, More Jobs: The Direct Employment Impacts of Developing a Sustainable Transport System in the United Kingdom,* 1997
- European Commission, *White paper – European Transport policy for 2010 – Time to decide,* 2001
- European Commission, RTD Energy, *European Fuel Cell and Hydrogen Projects 2002-2006*
- EEA, *Transport and environment: facing a dilemma TERM 2005: indicators tracking transport and environment in the European Union*, 2006
- France Nature et Environnement, *Pour une politique européenne de transports soutenables « Passons des discours a la mise en œuvre »* Commentaires et propositions, décembre 2005
- *La mobilité durable : Mesures pour une politique durable des transports en Europe,* Document présenté par Michael Cramer, député européen, dans le cadre de la Campagne « Stop aux changements climatiques », juillet 2006
- MTETM, *Le bilan social annuel du TRM*, mars 2006

- Office parlementaire d'évaluation des choix scientifiques et technologiques, Rapport *Définition et implications du concept de voiture propre,* par Christian Cabal et Claude Gatignol, 2005
- PLS Ramboll Management, *Potential of Community policies for Employment Promotion Transport and Energy*, August 2002
- RAC France, *Transports et changements climatiques : un carrefour à haut risque*, 2004
- SES, *L'emploi dans le transport routier de voyageurs Bilan social du transport routier de voyageurs*, février 2004
- TUSDAC, *Employment Creation and Environmental Policy: a literature review*, Chris Hewett and Julie Foley, A Report by Public Policy Research Associates Lt Commissioned by the Trade Union Sustainable Development Advisory Committee, 2000
- VCD e.V. Verkehrsclub Deutschland Öko-Institut e.V., *Chief benefits for the future New jobs created with environmentally-compatible traffic*, 1998
- Working Group Under the Joint Expert Group on Transport and Environment Reduction of Energy Use in Transport Final, *Report 18.01.2006*

Steel Metallurgy

- Agence internationale de l'énergie, Julia Reinaud, *Industrial competitiveness under the european union emissions trading scheme,* février 2005
- Agence internationale de l'énergie, *Energy Technology Perspectives. Scenarios & Strategies to 2050,* 2006
- René-François Bizec, *Gaz à effet de serre et changement climatique, quantification et instruments de lutte contre les émissions,* AFNOR, 2006
- Crédit Agricole Cheuvreux, *Impact carbone sur la sidérurgie*, novembre 2006
- Patrick Criqui et Christophe Rynikiewicz *Scenarios of energy and environment futures impacting the selection and diffusion of ULCOS technologies,* 2nd ULCOS seminar 2005
- DEFRA, ENTEC UK Ltd, *EU Emissions trading Scheme Phase II: Iron and Steel Sector,* final report, mars 2006
- Patrick Criqui, Silvana Mima, Christophe Rynikiewicz, LEPII-EPE CNRS, « Prospective énergétique à 2050, contrainte carbone et changements structurels », Atelier du 4 avril 2006 « Vers une représentation des économies sous contrainte carbone : enjeux structurels, industriels et technologiques », FONDDRI, 2006
- Eurofer, *Eurofer's concerns regarding the future EU climate Change policy (Post-2012)*
- Eurofer, *The position of the European steel industry on "An energy policy for Europe",* 25 avril 2006
- European foundation for the improvement of living and working conditions, *Industrial relations in the steel industry*, mai 2005
- Fercis, Fiches préparatoires au séminaire « Le changement climatique et l'acier », octobre 2006
- Institute for prospective technological studies, *Energy consumption and CO2 emissions from the world iron and steel industry*, European communities, mars 2003
- European Steel Technology Platform, *From a Strategic Research Agenda to Implementation: "A vision for the future of the steel sector"*, European Commission, mars 2006
- *Metal Bulletin* 2005-2006
- OCDE, *Environmental policy in the steel industry: using economic instruments*, janvier 2003

- Position paper of the alliance of Energy intensive industries: *Further guidance on allocation plans for 2008-2012,* Bruxelles, 1er février 2006
- Christophe Rynikiewicz, *Transitions for radical changes in the European steel industry*, LEPI EPE CNRS, Anvers, octobre 2005
- Syndex et Isa Consult, « La sidérurgie européenne du nouveau millénaire, prévisions d'emplois 1997-2007 » in *Le rôle des comités d'entreprise européens dans la restructuration de l'industrie européenne du charbon et de l'acier,* rapport FEM/ EMCEF, avril 1998
- Syndex et Isa Consult, *Les changements structurels de l'industrie sidérurgique européenne,* Rapport FEM, Bruxelles, juin 2004

Cement works

- European Commission (EC), *Best available techniques reference document in the cement and lime manufacturing industries. European Integrated Pollution Prevention and Control Bureau* (EIPPCB), IPTS, Sevilla, 2000
- Szabo L, Hidalgo I, Ciscar JC, Soria A, Russ P, *Energy consumption and C02 emissions from the world cement industry,* DG JRC-IPTS Report. Technical Report Series. juin 2003
- Szabo L., Hidalgo I., Ciscar J.-C. et Soria A., *CO_2 emission trading within the European Union* et *Annex B countries: the cement industry case,* Joint research Centre (DG Research), Institute for prospective technological studies (IPTS), 2006
- « Toward a Sustainable Cement Industry – Climate Change », WBCSD, March 2002
- Rapport du Batelle Memorial Institute commandé par le WBCSD, mai 2003, *Toward a sustainable cement industry*
- Etude sectorielle « Import carbone sur les cimentiers SRI », Sustainable & responsible investment-Cheuvreux, Octobre 2006
- OCDE-OECD, Damien Demailly and Philippe Quirion (Cired), *The competitiveness impact of CO2 emissions reduction in the cement sector*. novembre 2005
- Rapport du comité d'entreprise européen de Lafarge (assisté de la FETBB), *Les conséquences des quotas à effet de serre sur les importations dans le secteur du ciment en Europe,* février 2006
- *Stern report*, disponible sur le site : www.hm.treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm
- Prebay Y., Ando S., Desarnaud E., Desbarbieux T., *Les enjeux du développement durable au sein de l'industrie du ciment : réduction des émissions de CO2,* atelier « Changement Climatique » de l'Ecole nationale des Ponts et Chaussées, disponible sur Internet à l'adresse : http://www.enpc.fr/fr/formations/ecole_virt/traveleves/cc/cc0506/ciment.pdf
- Smale R., Hartley M., Hepburn C., Ward J., Grubb M., *The impact of CO_2 emissions trading on firm profits and market prices. Climate Policy* 6(1), 2006
- Rapport d'activité 2005, Cembureau
- Rapport d'activité 2005 Lafarge
- Rapport développement durable 2005 Lafarge
- Rapport d'activité Holcim 2005
- Rapport d'activité Italcementi 2005

- *Newsletter Holcim*, juin 2006, « L'industrie du ciment réduit ses émissions de CO2 et réalise le tiers de l'objectif imposé à la Suisse par le protocole de Kyoto »
- Statistiques Eurostat
- Statistiques Cembureau

Construction

- Rapport d'Ecofys pour Eurima, *Cost-effective climate protection in the EU building stock*, février 2005
- Rapport d'Ecofys pour Eurima, *Cost-effective climate protection in the building stock of the new EU member States, beyond the EU energy performance of buildings directive*, août 2005
- Ademe, *Un éventail de mesures pour renforcer l'efficacité énergétique des bâtiments*, janvier 2006
- Ademe, *Note de cadrage sur le contenu CO2 du KWh par usage en France*, janvier 2005
- Rapport du groupe de travail Facteur 4, *Division par 4 des émissions de gaz à effet de serre de la France à l'horizon 2050*, 9 octobre 2006
- Note d'étude n° 4 de la mission climat de la Caisse des dépôts, *Les enjeux de la réduction des émissions de gaz à effet de serre dans le bâtiment*, septembre 2005
- Groupe de travail Facteur 4, Alain Capmas, *Leviers R&D pour une réduction des émissions industrielles de CO2 à l'échéance de 2030 dans le secteur du bâtiment*, mars 2006
- Etude sectorielle *Bâtiments durables*, SRI-Cheuvreux, septembre 2006
- Rapport final à la Commission européenne (SAVE), *National and local employment Impacts of energy efficiency investment programmes*, Dr Joanne Wade, Victoria Wilshire, Ivan Scrase, ACE (Association for the Conservation of Energy), avril 2000
- Rapport de l'ACE (Association for the Conservation of Energy) au Energy Saving Trust, *Energy efficiency and jobs: UK issues and case studies*, septembre 2000
- OCDE-OECD, *Pour des bâtiments écologiquement viables, Enjeux et politiques*, 2003
- DG TREN, *Améliorer les performances énergétiques des bâtiments*, 2003
- OPET Work, *European network for the promotion of energy technologiy in the building sector work package 4 : innovative concepts and technologies for residential building refurbishment*, 2004
- European Commission, *European directive 2002/91/EC, 16 décembre 2002, on the energy performance of buildings*, 4 janvier 2003
- *The case for real CO2 reductions*, European Environmental Bureau, novembre 2000
- Rapport de mission ministérielle CGPC-IGE, *Comparaison européenne sur les mesures destinées à améliorer la performance énergétique des bâtiments*, janvier 2006
- Edition 2005 du programme de recherche sur l'énergie dans le bâtiment Prebat, *Énergie dans le bâtiment, volet technologique, une réponse au défi climatique*
- Rapport et avis du Comité économique et social France, *Les politiques de l'Habitat et de l'urbanisme face aux changements climatiques*, 2006

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European Trade Union Confederation [ETUC]
Confédération européenne des syndicats [CES]

Maison syndicale internationale (ITUH)
Boulevard du Roi Albert II, 5
B-1210 Bruxelles
Belgium
Tél : +32 (0)2 224 04 11
Fax : +32 (0)2 224 04 54
E-mail : etuc@etuc.org