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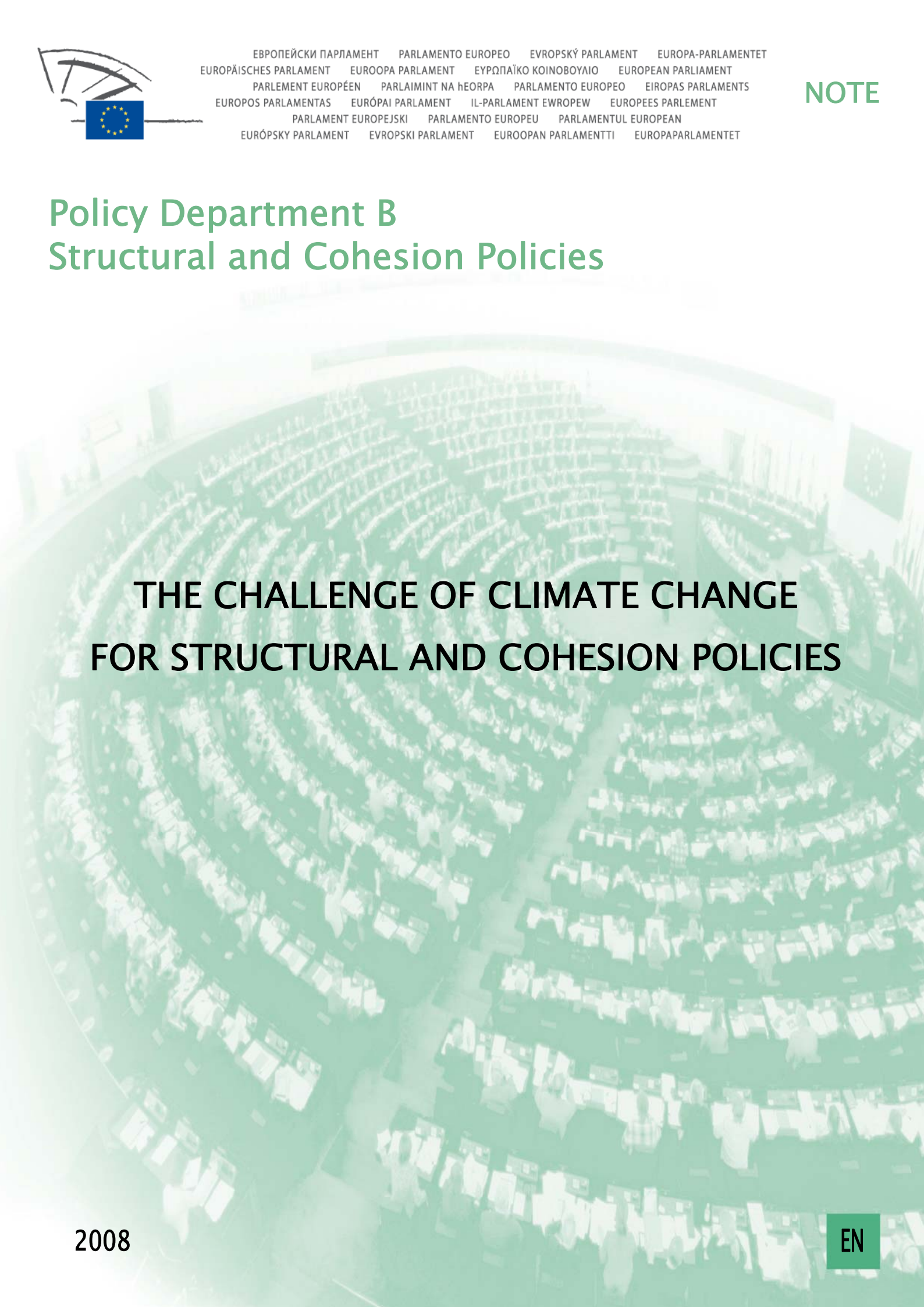
NOTE

Policy Department B
Structural and Cohesion Policies

THE CHALLENGE OF CLIMATE CHANGE FOR STRUCTURAL AND COHESION POLICIES



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Directorate General Internal Policies of the Union

Policy Department Structural and Cohesion Policies

THE CHALLENGE OF CLIMATE CHANGE FOR STRUCTURAL AND COHESION POLICIES

NOTE

Content:

The present note deals with the role played by Structural and Cohesion Policies, namely Agriculture, Fisheries, Culture, Transport and Regional Policies in the fight against climate change. The note aims at providing an overview of the problems, challenges, and policy options in these sectors.

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Abreviations and acronyms

CCPM	Community Civil Protection Mechanism
CFP	Common Fisheries Policy
ECCP	European Climate Change Programme
EEA	European Environment Agency
ENSO	El Niño Southern Oscillation
ESD	Education for Sustainable Development
ETS	European emissions trading scheme
FEDARENE	European Federation of Regional Energy and Environment Agencies
GDP	Gross domestic product
GHG	Greenhouse gas
HGV	Heavy Goods Vehicle
HOV	High-occupancy vehicle
ICT	Information and Communications Technology
IEG	Independent Evaluation Group
IPCC	Intergovernmental Panel on Climate Change
ISLENET	European Islands Network on Energy and Environment
JEGTE	Joint Expert Group on Transport and Environment
LCA	Low cost airlines
LDV	Light-duty vehicles
LEZ	Low Emission Zones
MIC	Monitoring and Information Center
MPAS	Marine Protected Areas
NAO	North Atlantic Oscillation
OECD	Organization for Economic Co-operation and Development
PT	Public Transport
SUTP	Sustainable urban transport plans
SUV	Sport Utility Vehicle
TENS	TransEuropean Transport Networks

CONTENTS

1. INTRODUCTION

Climate change presents a major global threat. The overwhelming majority of recent scientific research and reports on climate change[1] confirm that the current warming of the Earth's climate is to be due to human activities, above all the use of fossil fuels, agricultural practices and land-use changes. Climate change has begun, and the evidence is that it is accelerating. During the 20th century, mean temperature in Europe increased by more than 0.9ºC. At a global level, eleven of the last twelve years (1995-2006) rank among the 12 warmest years recorded since 1850 and the Earth's average surface temperature has risen by 0.74° C over the last 100 years. Mountain glaciers, snow cover and ice caps have declined on average in both hemispheres. Compared to 1990 it is estimated that average global temperature, between 1980 and the end of the 21st century, will increase in a range from 1.8°C (1.1 - 2.9°C) to 4°C (2.4 - 6.4°C), according to different scenarios calculated by the IPCC.[2]

Global warming is already having measurable consequences and its future impacts are expected to be very wide-ranging and costly. There will be unavoidable consequences, which will affect Europe as well as all other regions of the world. A series of adaptation measures will therefore have to be developed. We still have time to counter the impacts of climate change significantly. This will, however, require strong and early action to reduce greenhouse gas (GHG) emissions, in order to stabilise the concentration of GHGs in the atmosphere as soon as possible. The Policy measures applied within the next 20 years will play a key role. The longer emissions reductions are delayed, the more opportunities to attain lower stabilisation levels are jeopardised and the greater the risks of more severe climate change impacts become. According to the latest IPCC report global GHGs will be 25% to 90% above current levels by 2030. Around two-thirds of the global growth in GHG emissions will come from developing countries. Per capita emissions in 2030 will nevertheless be substantially higher in developed countries. According to the European Commission, limiting climate change to 2 degrees Celsius above the pre-industrial level is indispensable for avoiding severe, dangerous and irreversible impacts. This would globally require by 2050 a cut in GHG emissions of more than 50% of current levels and even more in developed countries and regions.

Economically, the benefits of tackling climate change now far outweigh the predicted cost. The Stern Review states clearly *"that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year."* Furthermore, in this review climate change is considered as *"the greatest and widest-ranging market failure ever seen" (Stern 2007, Summary of conclusion p.VI.).*

As climate change will have consequences on a global scale it has also to be addressed globally by taking drastic action. The EU has already been taking many significant steps to address its own GHG emissions since the early 1990s. Internationally, the EU was one of the key actors in developing and implementing the two major treaties on climate change, the 1992 United Nations Framework Convention on Climate Change[3] and its 1997 Kyoto Protocol[4]. At the Bali

[1] Two recent studies have attracted particular attention: *"Climate Change 2007"* the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) and the Stern review on the economics of climate change (Stern, 2007).

[2] A concise overview of the facts and risks related to climate change is provided on the following website: http://www.greenfacts.org/en/climate-change-ar4/index.htm#1

[3] http://unfccc.int/2860.php

[4] http://unfccc.int/kyoto_protocol/items/2830.php

Conference in December 2007 the EU was, furthermore, pressing for a roadmap for a global and comprehensive climate change agreement for the post-2012 era, as well as offering to commit to a 30% reduction below 1990 levels by 2020 if other developed countries would commit to similar efforts. The conference set a deadline for completing the negotiations on the future climate agreement by the end of 2009. Furthermore the findings of the recent scientific assessment by the UN Intergovernmental Panel on Climate Change (IPCC) were acknowledged, including the need for strong reductions in global emissions of GHGs to prevent global warming from reaching dangerous levels.

At EU level options for further action are currently subject to discussion and exploration over a wide range of Policy areas. On 23 January 2008 the European Commission proposed a package of legislative measures (*"20 / 20 / 20 by 2020"*)[5] as a response to the agreement reached under the German Presidency at the EU Summit in March 2007.

The European Parliament has set the fight against Climate Change as a top priority. A Temporary Committee on Climate Change was set up in April 2007. The Committee is to formulate proposals on the EU's future integrated policy on climate change and to coordinate the Parliament's position in the negotiations regarding the international framework for climate policy after 2012. It shall propose appropriate measures, at all levels, accompanied by an assessment of both their financial impact and the cost of inaction. The Committee will produce a detailed report so that the EP's Position will be available in good time before the crucial United Nations Conference to be held in Copenhagen in December 2009.

To fight climate change a holistic approach and efforts in a broad variety of political sectors are needed. This note deals with the role of Structural and Cohesion Policies, namely Agriculture, Fisheries, Cultural Policies and Education, Transport and Regional Policies, in addressing the climate change challenge.

These sectors will be particularly important as some of them

- will be particularly affected by climate change (e.g. Agriculture, Fisheries, coastal regions)
- are driving forces for climate change (e.g. Transport but to some extent also agriculture)
- can horizontally contribute to solutions (Regional and cultural policies as well as agriculture).

The note aims at providing an overview of the problems, challenges, and policy options in these sectors.

[5] The proposal aims at a 20% increase in energy efficiency, 20% reduction in greenhouse gas (GHG) emissions, and a 20% share of renewable energy in overall EU energy consumption, all by 2020. Furthermore, a 10% biofuel component in vehicle fuel by 2020 was proposed. The key elements of the package are: a) an updated and enlarged Emissions Trading System involving all major industrial emitters; b) specific, binding national targets for sectors not covered by the ETS such as buildings, transport, agriculture and waste; c) a new approach to promote renewable targets, again including binding national targets; d) new rules to stimulate carbon capture and storage; new guidelines for environmental state. EC, European Commission, 2008. Communication from the Commission: 20 20 by 2020, Europe's climate change opportunity, COM(2008) 30.

2. AGRICULTURE AND CLIMATE CHANGE

2.1. Agriculture, an activity linked to the specific local environment and dependent on an unpredictable climate

Although climate change is having an impact on the economy as a whole, agriculture is probably one of the sectors most at risk, given its dependence on *climatic conditions* and *geographic constraints.*

Agriculture is an economic activity which takes place in the midst of a natural environment whose balances it must respect and optimise. In that sense, agriculture manages and cultivates the world around us. Without agriculture, there can be no organised land use and no local economy.

Utilised agricultural area in Europe (EU-27) amounts to 183.2 million ha, i.e. 47 % of the total surface area of the Union. When forests are included, primary activity accounts for 78% of the surface area of the Union (EC, 2007a, 13 and 132). Agriculture and forestry are thus primarily responsible for managing four-fifths of the land area of Europe and, on that basis, act as guarantors of fundamental ecological balances.

It is against that background that agricultural policies are gradually broadening the traditional function of agriculture, i.e. the production of foodstuffs, other dimensions, including regional development, environmental management or the production of energy and biomaterials.

The reform of the Common Agricultural Policy (CAP), which today is based on the so-called *health check*, confirms the growing interest the Community authorities are showing in new roles for agriculture. The Commission Communication of 20 November 2007 (EC, 2007b), which is currently being debated in the institutions, has no hesitation in describing *climate change* as the main challenge which European agriculture will be required to meet in the future. Other closely linked issues - more effective water management, the protection of biodiversity and the exploitation of the full potential offered by bioenergies - are all aspects of agricultural policy which could, indirectly, help the fight against *climate change.*

2.2. Agriculture: cause and victim of climate change

With a total of 477 million tonnes, European agriculture is responsible for a small proportion (9.2%) of the EU-27's greenhouse gas emissions, in particular nitrogen protoxide (5.3%), as a result of the breakdown of nitrogen-based fertilisers in the soil, and methane (3.9%) as a by-product of livestock farming[6].

In addition, these emission levels are falling: emissions attributable to agriculture decreased by 20% between 1990 and 2005 and a 23% reduction is expected between now and 2010, subject to the implementation of a *Community agro-climate strategy* to encourage the development of sound practices in the area of fertiliser use, animal feeding, the curbing of energy consumption and the methanisation of livestock effluents (biogas).

Agriculture is (above all) a *victim* of climate change and can *make a decisive contribution to the fight against global warming*. First of all, attention should be drawn to its role in producing renewable energy resources, the equivalent of 3.4 million tonnes of oil (2005), a major

[6] Sources: EC 2007a, 13 and 160; EC 2008.

contribution to offsetting the impact of climate change. Forestry's contribution is much more substantial still: in 2005 production was the equivalent of 63 million tonnes of oil.

What is more, reducing climate-related risks offers agriculture new opportunities: on the one hand, *biomass* products can be used as replacements for fossil fuels, and, on the other, *carbon capture* in the soil is taking on greater importance. However, many issues have still to be resolved in these areas: as regards biomass, the precise terms of government policies on the development of biofuels (the *energy challenge*), and, as regards carbon capture, the issue of the possible remuneration of beneficial agricultural practices under the CAP and/or projects linked to the Kyoto Protocol (leading to an *environmental challenge*, that of fostering sustainable agriculture).

There is also an e*conomic challenge* to be overcome, i.e. the fight against price and income instability, which is exacerbated by climatic fluctuations. Lastly, agriculture and forestry will be required to meet a genuine *spatial planning challenge*: they are becoming a vital tool in a European strategy to prevent natural disasters, in that they occupy and manage the land, protecting it against abandonment, soil erosion or the risk of fire.

2.3. Agriculture in the face of climate change: the challenges to be met

Climate change is giving rise to *four challenges* which the CAP will be required to meet.

2.3.1. The spatial planning challenge: the prevention of natural disasters

Agriculture and forestry are particularly vulnerable to climate-related risks (floods, storms, drought and/or forest fires). The flooding and droughts suffered in recent years foreshadow the long-term impact of *climate change* on agriculture: natural disasters of all kinds, which are today regarded as exceptional, could become recurring phenomena[7].

It should be borne in mind that the consequences of global warming on *regions* will not be uniform. As regards rainfall levels, the EU straddles climate zones and could find itself affected by an increase in rainfall in northern Europe and a reduction in rainfall in southern Europe. Moreover, the impact on *yields* is the result of *direct effects* on the ecophysiology of crops, given the increased concentrations of carbon dioxide in the atmosphere, which stimulate photosynthesis and lengthen plant-growing periods, and *indirect effects* linked to rainfall levels and the availability of water resources, the risk of drought and soil erosion.

Against this background of tension between competing forms of water use, the issue of irrigation for farming purposes where conditions are most critical will inevitably arise at national and European level. As a result, agricultural policies will be faced with a hydrological challenge in years to come.

2.3.2. The environmental and hydrological challenge: sustainable agricultural development

Agriculture is fundamental to environmental policies, through its role in preserving biodiversity and natural resources and combating pollution.

[7] The European Drought Observatory, managed by the *Joint Research Centre* (JRC), provides detailed information on the development of these phenomena. In addition, the European Commission is in the process of developing a cross-border crisis-response cooperation system.

The agricultural sector is by far the largest user of water resources, in particular in Mediterranean countries, given the need for artificial irrigation. In some southern Member States, irrigated land may make up as much as one-fifth of total farmland, a proportion which is continually rising. Since 1985, the area of irrigated land in Mediterranean countries has increased by 20%. In these countries, water for irrigation can account for up to 75% of total water consumption.

As the main water user, in environmental and agro-climatic terms agriculture is the cause of many *positive and negative external effects*. Taking the positive effects first, it is the main guarantor of the density and diversity of European landscapes, is responsible for carbon capture in the soil at local level, and safeguards plant and animal biodiversity. As regards the negative effects, the most obvious is the squandering of a rare resource through *intensive irrigation* or *groundwater depletion* stemming from non-sustainable agricultural practices. Indeed, in some areas of southern Europe the over-exploitation of natural resources is giving rise to serious problems involving soil erosion, desertification and water salinisation.

Agriculture also *undermines water quality* in various ways: contamination by plant-health products, nitrate pollution, in particular as a result of intensive animal husbandry, or phosphorous flows carried off by surface water currents (as a result of the use of fertilisers or the large-scale spreading of livestock effluents).
As well as meeting food needs, in the future European agriculture will be required to reconcile economic performance with ecological effectiveness, in order to achieve a sustainable development approach.

2.3.3. The energy challenge: biomass production

Given the limited reserves of fossil fuels, and with a view to honouring the undertakings given in the context of the Kyoto Protocol, the EU has embarked on a strategy of diversifying its sources of supply with a view to meeting its energy needs.

The development of biofuels and biomass could (in principle) help the EU achieve that objective. However, it should be borne in mind that, depending on how they are implemented, government strategies to develop *biofuels* could have an adverse impact on the environment and biodiversity. There are a number of *potential risks* inherent in the proposed expansion in the use of biofuels derived from biomass: risks of a depletion in water reserves, if the basic material used is maize; risks of water pollution and soil erosion, as a result of the concentration of biofuel production in certain regions where agricultural conditions are poor; risks of a failure to comply with standards governing concentrations of pesticide residues in non-food plants; and, finally, risks of an explosion in commodity prices should the expansion in biofuel production give rise to speculation on the futures markets.

For these reasons, the Commission's proposals as part of the *2008 CAP Health Check* already emphasise the need for government policies to focus now on the development of *second-generation biofuels* (produced from waste and lignocellulose). This would serve to reduce in the medium term the potential risks linked to an expansion in biofuel production.

2.3.4. The economic challenge: risk management

The impact of climate change on yields will further exacerbate *price volatility*, which has already been increased by the opening-up and globalisation of markets. Price instability equals risk, creating a need to *manage that risk*. Against a background of greater exposure to unforeseen environmental, health and economic problems, CAP reviews will inevitably have to give detailed consideration to more effective mechanisms to reduce fluctuations in production and income.

That review will have to equip the CAP with new market stabilisation tools, develop individual risk cover arrangements (insurance policies, mutual funds) and, lastly, enhance the ability of farmers' associations to manage production.

As part of the *2008 CAP Health Check*, the Commission has already proposed, for the financial years 2010 to 2013, a 2% annual increase in the compulsory modulation of market support payments. These amounts could be used for risk management, through the implementation of measures compatible with the requirements of the World Trade Organisation (WTO). Consideration might also be given, sector by sector, to additional measures to be taken when market mechanisms are adjusted in the future (e.g. safety nets).

2.4. Towards sustainable agricultural development: the *2008 CAP Health Check*

In conclusion, the agricultural sector will in future be required to make greater efforts to reduce the impact of climate change. The challenges outlined above in connection with the fight against global warming will certainly have economic implications, since spending will be needed to address them. To some extent, adjustment measures under the CAP will have to be improved and, more specifically, *existing tools* will have to be enhanced with a view to reducing water contamination, promoting sound agricultural practices, supporting the adjustment and/or conversion of more water-intensive production systems, managing new climate- and market-related risks, and, finally, improving the energy and hydrological efficiency of farms.

The Commission proposals presented in the context of the 2008 CAP Health Check are already placing the emphasis on strengthening the *cross-compliance rules governing aid decoupled from production* and existing *rural development measures* with a view to enabling the CAP to meet the new challenges.

The introduction of *decoupling* since 2003 has reduced the incentive to produce more despite unfavourable market trends. In addition, the *cross-compliance* rules governing decoupled aid payments (i.e. making payments subject to compliance with other provisions of Community law) is clearly consistent with the need to integrate the objectives of the CAP into environmental protection policy. In future, cross-compliance will have to be used as a tool to meet goals in the area of climate change or more effective water management by means of statutory provisions and codes of good agricultural practice.

Moreover, most of the *agro-environmental measures* under the second pillar of the CAP are already having a positive impact on water use and water quality, the protection of biodiversity and the combating of soil erosion. In particular, they are funding reductions in the use of pesticides or fertilisers in agricultural production and the rationalisation of irrigation. Implemented in the *Natura 2000* zones (which make up 10% of farmland in the EU-27), these measures are also helping farmers strike a balance between economic activity and the environment and making it easier for them to respect biodiversity and the landscape. At EU-27 level, agro-environmental measures are by far the most significant in financial terms in the context of the new rural development policy established for the *period 2007-2013.* They will account for 22% of total EAFRD payments (EC, 2007a, 26). In future, this agro-environmental policy strand will have to be strengthened with a view to offsetting the impact of climate change, improving water management and, possibly, developing second-generation biofuels.

2.5. The agricultural challenges of climate change as reflected in parliamentary work during the 2004/2009 parliamentary term

A growing proportion of Parliament's work already focuses on the overall issue of the impact of climate change on agriculture. In addition to many opinions drawn up for the Committee on the Environment, Public Health and Food Safety (COMENVI), the committee responsible for framework environmental legislation, the Committee on Agriculture and Rural Development (COMAGRI) has adopted three *own-initiative reports* which deal very specifically with agro-climatic problems:

2.5.1. The challenge of risk and crisis management in agriculture

A 2005 Commission Communication on risk and crisis management in agriculture[8] gave COMAGRI an opportunity to outline its views on this topic by means of an *own-initiative report*[9]. First of all, the Members of the committee noted that the risks which climate change, soil degradation, water shortages and the erosion of genetic resources pose for agricultural production will increase in terms of variety, intensity and frequency. They expressed reservations concerning the philosophy underpinning the Commission proposals, which were based solely on compensation and indemnification, rather than prevention. They called on the Commission to pay greater attention to instruments which could prevent a collapse in prices or market crisis as a result of the liberalisation of trade. COMAGRI also took the view, given the challenges faced, that funds for crisis prevention, including reserves, should be increased. Finally, it called for crisis management policy in the agricultural sector to be flexible and to be based on a pluralist approach, since the wide range of insurance schemes and regional characteristics ruled out the choice of a single crisis management model.

2.5.2. The regional challenge: concern at the impact of natural disasters on agriculture

Following a number of EP resolutions[10] on the natural disasters which occurred repeatedly in 2005, COMAGRI prepared an *own-initiative* report on *natural disasters (forest fires, drought and floods)*[11].

The resolution adopted in plenary pointed out that natural disasters undermine sustainable development in that they accentuate rural depopulation, intensify erosion and desertification problems, damage ecosystems and endanger biodiversity; it called for recognition of the specific features of natural disasters in the Mediterranean region, such as drought and fires; called for a genuine Community strategy for dealing with disasters using a variety of flexible financial mechanisms; emphasised that the existence of a wide network of agricultural SMUs and an agricultural policy promoting more sustainable production methods is a vital precondition for fighting the effects of drought and forest fires; recommended that, in national and regional development programmes, priority should be given to measures aimed at the causes of natural disasters (hydraulic projects, watersaving, the fight against erosion, etc.); and called for the establishment of a European Drought Observatory.

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8 COM(2005)74.

9 Graefe zu Baringdorf report (2005/2053(INI) - A6-0014/2006 - P6_TA(2006)0067).

10 Resolutions of 14 April 2005, 12 May 2005 and 8 September 2005.

11 Capoulas Santos report (2005/2195(INI) - A6-0152/2006 - P6_TA(2006)0222).

2.5.3. The new CAP: the report on the communication on the 2008 CAP Health Check

The Commission Communication of 20 November 2007[12] *on the CAP Health Check* led to COMAGRI drafting an own-initiative report[13] which answers most of the questions raised concerning the interaction between climate and agriculture. For example, the members of the committee: (1) advocate bringing good agricultural practices into line with changed environmental and production conditions (climate change, hydraulic management, biomass); (2) take the view that, if direct payments without cross-compliance can no longer be justified, cross-compliance should be restricted to checks on essential standards; (3) takes the view, further, that given the increase in environmental and climate dangers and in the risks of epidemics and considerable price fluctuations on agricultural markets, additional risk prevention is of vital importance as a safety net; (4) stress that supplying renewable energy should not be pursued one-sidedly to the detriment of livestock farming, food security, sustainability and biodiversity; call, therefore, for appropriate funding for research and the development of second-generation biofuels; finally, (5) take the view that the new CAP must focus more strongly on aspects of the territorial coherence and integrated development of rural areas, rewarding effort and compensating for extra burdens, and risk management; the relationship between the first and second pillars must therefore be entirely redefined.

[12] See footnote (2).
[13] Goepel report (2007/2195(INI) - PE 398.676v01-00).

3. CLIMATE CHANGE AND FISHERIES

3.1. Introduction

The effects of climate change on fisheries will affect a sector that is already characterised by full utilisation of resources, presenting significant impacts – positive or negative – on most commercial fish stocks. Changes in the productivity of the ecosystem will have a profound effect on the sustainability of fisheries. In addition, the frequency and intensity of extreme climate events is likely to have a major impact on future fisheries production in both inland and marine systems.

As a response to previous climate changes and climate fluctuations, marine ecosystems have developed a capacity for adaptation. However, the rate of future climate change is predicted to be more rapid than previous natural changes and the resilience of species and systems is being challenged by competing pressures, including fishing, loss of genetic diversity, habitat destruction, pollution, introduced and invasive species, and pathogens.

The impacts of fishing and of climate change interact, and they cannot be treated as separate issues. Fishing causes changes in the distribution, demography and stock structure of individual species, and direct or indirect changes in the geographic diversity of populations and the biodiversity of marine ecosystems, making both more sensitive to additional stresses such as climate change.

3.2. High confidence forecasts on the impact of climate change[14]

There are a wide number of previsions on processes linked to climate change, but the degree of scientific consensus for each of these previsions is very different. Nevertheless, there is a wide scientific consensus on several processes linked to changes in the properties of water and on hydrographical changes.

3.2.1. Changes in the properties of water

Temperatures will increase and sea levels will rise.

Average global temperatures have increased by ~0.6°C and sea level has risen 0.17m over the past century. The coastal marine climate of Europe is predicted to continue to warm throughout the 21st century, with the forecast for the sea surface temperature to increase by 0.2°C per decade.

In the North East Atlantic, where temperature change has been rapid, there have been rapid poleward shifts in the distribution of fish and plankton. Further changes in distribution and productivity are expected due to continuing warming and cooling of the Arctic. Some of the changes are expected to have positive consequences for fish production, but in other cases reproductive capacity is reduced and stocks become vulnerable to levels of fishing that had previously been sustainable. Localised extinctions are occurring at the edges of current ranges, particularly in freshwater and diadromous species such as salmon and sturgeon.

[14] The study *"Climate Change and European Fisheries"*, carried out for the European Parliament (EP 2007a).

Model estimates predict ocean acidification.

A pH reduction in the ocean surface range from 0.3 to 0.5 units is predicted over the next 100 years and from 0.3 to 1.4 units over the next 300 years.

Salinity will change.

In the nordic seas and the Baltic, decreases in salinity are expected, whereas in the Mediterranean salinity is expected to increase.

Climate change impacts may be even more severe in semi-enclosed seas than in the open seas.

In the Baltic Sea the prognosis for a decrease of salinity ranges from 8% to 50% and for the increase in temperature of the sea surface water from 2 to 4°C. In the North Sea region, the prognosis for salinity is variable with expected increases and decreases in different areas of the North Sea. The sea surface temperatures are predicted to rise about 1.6°C to 3.0°C in the northern North Sea and 3.0°C to 3.9°C in the shallower southern North Sea.

3.3. Hydrographical changes

Future production may increase in some high-latitude regions because of warming and decreased ice cover, but the dynamics in low-latitude regions are governed by different processes, and production may decline as a result of reduced vertical mixing of the water column and, hence, reduced recycling of nutrients.

The Atlantic thermohaline circulation will be weakened.

The water bodies of the North Sea and Arctic regions interact by exchange of cold and warm water flows, driven by the Atlantic thermohaline circulation. Flow intensity is influenced by climate change. Currently, it is estimated that flow intensity may already have been reduced by 30%. However, it is unlikely that the circulation will shut down completely; this would have strong impacts on current patterns (e.g. a short term sea level rise in the North Sea of 1m, a long term global sea level rise of 0.5m, a southward shift of the tropical precipitation belt and a 50 % reduction in biomass in the Atlantic).

The North Atlantic Oscillation impacts on the European marine ecosystem.

The “North Atlantic Oscillation” (NAO) dominates the atmospheric behaviour in the North Atlantic, affecting all marine trophic levels. Recruitment of commercial fish is linked to the NAO index as demonstrated for the gadoid outburst (concerning cod, haddock, whiting and saithe) in the North Sea and for herring and sardine recruitment in the Northeast Atlantic. The NAO is highly unpredictable, although it is possible to reconstruct the NAO from sea surface temperature. The analyses of the NAO index and the relation to observed impacts on the marine ecosystem may enable the development of models for predicting future impacts.

Stratification will increase.

Climate change causes increased stratification of the Baltic Sea, the North Sea and the Mediterranean Sea. Stratification of the water column leads to natural barriers where organisms can concentrate or where organisms have to pass through. Stratification increases with increasing salinity and temperature. Increased stratification hinders mixing with deep water and causes reduced replenishment of nutrients.

Changed circulation and stratification will change the geographical distribution of organisms.

Currents play an important role in transporting organisms like plankton and fish over large distances and can thus increase their distribution range. On the other hand, currents also act as a biogeographical barrier between the water masses on both sides of a current. They reduce the exchange of organisms across the current. Warming may lead to a weakening of alongshore currents, thus decreasing the distribution within the alongshore current, but breaking down the barrier between coastal and offshore water. This may lead to range extension of organisms previously trapped near the coast. All these effects impact (positively or negatively) on primary production.

3.4. Effects of Climate Change[15]

Recent changes in the distribution and productivity of a number of fish species can be ascribed with high confidence to regional climate variability, such as the El Niño–Southern Oscillation.

A likely scenario for the future of the North Sea is an increase in temperature, high NAO and increased inflow of Atlantic water. This scenario would lead to low recruitment of Atlantic cod, a northward shift of present fish species (cod, herring and sprat) and an invasion of southern species (sardine and anchovy).

Processes linked to climate change have both direct and indirect effects on distribution, productivity, and extinction of fish stocks that are exploited commercially. Expected impacts will have negative and positive effects on marine productivity.

3.4.1. Direct effects act on physiology and behaviour and alter growth, development, reproductive capacity, mortality, and distribution.

Temperature is a fundamental component of the ecological niche of fishes. Fish tend to select thermal habitats that maximise their growth rate. However, predicting the effects of temperature change on fish is difficult, because, in addition to temperature, food availability and suitable spawning grounds determine the large scale distribution of fish. Small changes in temperatures can be crucial for the spawning and growth rate of a fish stock. Changes in the abundance and distribution of fish and zooplankton related to a rise in sea temperature have been observed. So, direct and indirect climate effects can lead to a shift of fish populations, the invasion of alien species and even to the disappearance of species.

Climate change influences abundance and distribution of commercial species. Changing climate has a direct influence on survival rates, dispersal, fertility and behaviour of individuals and thus on abundance and distribution. Predictions are difficult since many factors other than climate impacts play an important part in determining species distribution and the dynamics of these changes. In addition, climate change presents indirect effects due to bottom up processes linked to variations in phyto- and zooplankton production.

Climate change has been implicated in mass mortalities of many aquatic species, including plants, fish, corals, and mammals, although lack of adequate data makes it difficult to attribute causes.

[15] EP, 2007a.

3.4.2. Indirect effects alter the productivity, structure, and composition of the ecosystems on which fish depend for food and shelter.

Indirect effects of climate change are mainly related to changes in the food web or to the shift in populations. However, these processes may be closely linked.

3.4.2.1. Impact of changes related to the food web

Climate induced disturbance of the food web impacts on survival and productivity of commercial species.

For the survival and productivity of fish, it is crucial that the abundance of fish larval stages match the occurrence of the right sized zooplankton. Due to climatic changes many plankton taxa have been moving forward in their seasonal cycles. This leads to mismatches with severe implications on the survival and productivity of commercial fish stocks. If temperatures continue to rise, such disturbance of the marine food web will continue and will impact on the abundance and distribution of commercial fish. A shift in the balance between meroplankton and holoplankton, and thus between benthos and pelagial, influences the survival of larval fish.

Effects of climate change on plankton lead to shifting fish populations.

Many commercial fish species are directly plankton-dependent. Plankton-feeding fish species, in particular sardine and anchovy, show strong natural fluctuations with climate variations. Investigations related to climatic warming indicated shifts from a dominance of northern species to a dominance of southern species. Shifts in boundaries using more than 60 different North Sea fish species showed a shift of boundaries of half of the species with a northward trend. Some species may have reached their tolerance limits, such as cod in the North Sea, resulting in northwards movement of their populations. The decrease in cod was correlated with changed species composition, stock decline and smaller average body size of the zooplankton. This can probably be attributed to climate change. The shift of some populations can lead to the complete loss of stocks at the regional level.

Climate change impacts on prey and predators of commercial species.

Important organisms of the biotic environment of the commercial key fish species are their prey and their predators. For the planktivorous fish species the main prey organisms are small and large copepods. Being important elements of the food web, their responses to climate impacts are crucial for the productivity of industrial fish stocks.

3.4.2.2. Impact of changes related to the shift of populations

Climate change can lead to shifts of fish populations, and invasion by alien species, enabling both competitive species and pathogenic species to spread to new areas. It may also lead to disappearance of species or alter the specific behaviour of fish populations, provoking time or spatial shifts of fish stock abundance, or changes in migration routes.

Invasive species are becoming more frequent in European coastal waters.

Biological invasion has become one of the most prominent elements of global change. Sometimes, invasions are brought about or favorised by changing climate conditions. Biological invasions can alter the biodiversity and functions of natural ecosystems and can cause significant economic damage.

Climate change causes shifts of commercial species populations.

Variations in temperature or salinity induce changes of interactions (food organisms, predators, competitors, reproduction) resulting in the shift of populations. There is a need to conduct studies on population and community levels, since direct climatic effects on individuals do not translate directly into changes in distribution and abundance of fish populations.

Warm fish species invade "cold" ecosystems.

Several warm fish species have invaded "cold" ecosystems and cold species which used to be relatively abundant in "warm" ecosystems have become very scarce or have disappeared. Since the considered species are often heavily exploited, the establishment of direct causal relationships between temperature and distribution pattern is difficult. Reliable prognoses on the probable development of fish stocks due to climate change effects are only possible for some intensively investigated species (e.g. Atlantic cod). Separation from other impact factors is difficult and research is needed.

3.5. Possible impacts on inland fisheries and aquaculture[16]

3.5.1. Inland fisheries

Climate change has direct effects, through reduced precipitation and greater evaporation, and indirect effects when more water is used for irrigation to offset reduced precipitation.

Many inland fisheries are threatened by alterations to water regimes that, in extreme cases, cause whole lakes and waterways to disappear.

Inland fisheries are additionally threatened by changes in precipitation and water management.

3.5.2. Aquaculture

Aquaculture production is rising rapidly, and by 2030 it is estimated that it will be close to that of capture production.

Further development of aquaculture depends, among other things, on the continuing availability of suitable feed sources, which is by no means assured.

Aquaculture poses some additional threats to capture fisheries, and the development of aquaculture could affect the resilience of capture fisheries in the face of climate change.

Threats to aquaculture arise from:

- stress due to increased temperature and oxygen demand and decreased pH,
- uncertain future water supply,
- extreme weather events,
- increased frequency of diseases and toxic events,
- sea level rise and conflict of interest with coastal defences, and
- an uncertain future supply of fishmeal and oils from capture fisheries.

[16] *Global Fish Production and Climate Change*, Brander. ICES 2007.

However, both positive and negative effects are expected. The regional distribution of the impact of positive or negative effects can be very diverse. It is unknown whether the positive effects will outweigh the negative effects or vice versa.

Among positive effects, productivity may rise due to increasing growth rates and feed conversion efficiency, longer growing season, range expansion, and the use of new areas as a result of decreasing ice cover. It could also be possible to introduce new species to aquaculture.

On the other hand, negative effects such as thermal stress for coldwater species and intertidal organisms, diseases and disease susceptibility are expected. Also damage to fish farms due to extreme weather events is possible. It may be necessary to shift production centres to more appropriate locations according to changed environmental conditions. In addition there are concerns that heat waves may cause significant economic impacts in particular to production sites that are situated in shallow water close to the coast. The increasing demand on fishmeal by the aquaculture increases the sensibility to processes like El Niño Southern Oscillation (ENSO). The long term impact of climate change on El Niño is unknown.

3.6. Possible Policy Options[17]

3.6.1. Climatic uncertainties and policy options

Fisheries are based on renewable resources. Most of them are affected in different degrees by climatic uncertainties. So, fisheries resources and climatic uncertainties are linked by a variety of interrelated factors, hydrographical, environmental or ecological.

The principal impacts on future fisheries production identified are expected to act progressively in a linear response and to interact with each other. However, marine ecosystems can also respond to changes in physical or biological forcing in a nonlinear way, when a threshold value is exceeded and a major change in species composition, production, and dynamics takes place. Nonlinear changes may be hard to predict, and will usually have abrupt impacts in productivity and species composition. Even if such nonlinear responses occur, it is not fully understood how or under what conditions. This is a key limitation to forecasting future states of marine ecosystems.

Renewable resources collapse when they reach a critical stock level. A collapse can be provoked by high fish mortality due to high levels of harvesting or by unfavourable environmental conditions. Uncertainty may hinder the evaluation of the risks of collapse and political and economic motives may reinforce the problem.

Policy options must provide an adequate response, avoiding subsequent and more acute crisis. When determining the harvesting level on the probability of collapse of the resource, different policy options should take into account the uncertainty about the true level of the resource and how future climate change will affect its growth rate.

It is uncertain whether it is the positive or negative impacts of climate change on EU fisheries which will predominate. In many aspects, knowledge and understanding of relations and interactions between the marine ecosystem, fisheries, aquaculture and climate change is deficient. For this reason, enhancing research is a key element in whatever policy mix is to tackle climate change.

[17] Brander 2007; EP, 2007a.

3.6.2. Possible Policy Options

Possible options should be in line with the objectives of the EU Adaptation Programme under the European Climate Change Programme (ECCP) to explore options to improve Europe's resilience to climate change impacts in different sectors. In addition, it is vital to take into account the sustainability aspects in the sense of reducing emissions of greenhouse gases. The CFP should be instrumental in implementing corresponding strategies, and possible options should use a knowledge based proactive approach.

3.6.2.1. Strategies to increase resilience of fish populations.

The response of fish stocks to environmental influences depends on population size. Healthy stocks can better adapt to population displacement and changes in ecosystem structure and respond better to climate impacts. Stocks that are drastically reduced by overfishing are more vulnerable to climatic changes than sustainably exploited stocks. In these cases, as fishing is size-selective and causes changes in the size and age structure of populations, it results in greater sensitivity to climate fluctuations. Therefore, current fishing practice decreases the resilience of over-exploited fish stocks against climate change impacts, and can increase the risks of environmental impacts for fish stocks.

The Common Fisheries Policy (CFP) has a key role in managing fish populations and should take possible climate impacts on fish stocks into account. It could be an appropriate instrument to implement corresponding strategies to increase the resilience of fish stocks against the impact of climate change.

Development of strategies for sustainable fishing could compensate the decrease resilience of fish stocks against environmental changes. Reducing fishing mortality in the fisheries which are currently fully exploited or overexploited, is the principal feasible means of reducing the impacts of climate change.

3.6.2.2. Strategies to improve fish stock management.

An important question is how future commercial fishing should be managed in the light of climate effects on the marine environment. Climate change can create some problems in current management systems. As quota systems and marine protected areas are vulnerable to distribution shifts, historically based schemes such as catch quota allocations could cease to correspond to changing distribution and population levels. In addition, measures of sustainable productivity and reference points for management might not remain constant.

Future sustainable fisheries depend on effective management of fishing activity, which in turn requires an understanding of the effects of climate change on the productivity and distribution of exploited stocks. Management must take into account the interactive effects of fishing, climate, and other pressures. It should also develop flexible fish stock management strategies and concepts that are adjustable to the responses of fish stocks to environmental conditions.

Fisheries management systems need adaptation in order to deal with the additional risks and uncertainties imposed by climate change. Uncertainties and the possibility of nonlinear, abrupt changes in productivity and species composition also points to the need for a precautionary approach to fisheries management. Because nonlinear changes may be hard to predict, the management system must be able to respond quickly.

Efficient exploitation requires an adjustment of fish stock management to the shifts induced by climate change. As several relevant commercial key fish species (such as herring and probably

other small pelagic species) respond highly to varying hydrographical conditions, future fish stock management should be continuous, but flexible and adaptable according to the responses of fish stocks to future environmental conditions. Management systems should also adapt to alterations of the migration routes of highly migrative species, due to a changing environment.

In order to face possible climate changes, stocks management should aim to preserve the resilience of fish populations, and when convenient, the preservation of their age and geographic structure as well as their biomass.

A flexible and adjustable regime of fish stock management is needed in order to avoid negative economic impacts. Some of the attributes to be enhanced in fisheries management systems in order to confront climate change are:

- flexibility,
- adaptability to new information about the marine ecosystem,
- reflexivity (i.e., continuous evaluation of the consequences of management in relation to targets), and
- transparency in the use of information and in governance.

In order to be able to adjust fisheries management in good time, research is needed to improve understanding of the impacts of climate change and related prognoses on EU fisheries.

The ecosystem-based approach, that goes beyond the assessment and management of just a few commercially important species, provides a better basis for incorporating climate-induced changes. The inclusion of environmental factors in fish population models can alter the prognosis on how populations will behave. Simulations can provide management advice and show that the inclusion of environmental effects may become increasingly important in fish stock management.

High priority should also be given to the development of strategies and concepts in order to minimise negative impacts on marine aquaculture.

3.6.2.3. Stimulation of relevant research and sharing of knowledge.

All possible policy options are related to significant research needs. It is indispensable to have appropriate knowledge of and insight into relations and interactions between the marine ecosystem, fisheries, aquaculture and climate change. A sound knowledge base is a prerequisite for the development of efficient strategies for sustainable fishing, fish stock management and for marine aquaculture in view of the threats of climate change. The EU could stimulate and/or support corresponding research in order to improve the factual basis for its policy decisions and the strategies to be developed and could contribute to the dissemination of the created knowledge.

Needs related to effects on properties of water and key fish species

Need for further studies on the behaviour of thermohaline circulation in view of a changing climate. Available global circulation models driven by climate scenarios have been treating the marine environment and changes in ocean climate in a simplified way. Methodologies have to be further developed for the downscaling of global models to regional scale models.

Research is needed for the assessment of climatic effects separated from other impact factors. Distributional shifts have been shown in many cases, but since the considered species are often heavily exploited, the establishment of direct causal relationships between temperature

and distribution patterns is difficult. Reliable predictions about the probable development of fish stocks due to climate change effects are only possible for some intensively investigated species (e.g. Atlantic cod).

Need to conduct studies on population and community levels. Several examples for temperature or salinity induced interactions (food organisms, predators, competitors, reproduction) resulting in the shift of populations have been observed and can explain some interactions and internal changes in ecosystems. Climatic effects on individuals do not translate directly into changes in distribution and abundance.

Enhanced research is needed on semi-enclosed areas, since they will be the most affected by climate driven changes and are therefore highly vulnerable.

Needs related to effects on the biological environment of commercial fish species

It is not possible with the current state of knowledge to make quantitative predictions about changes in global marine production due to climate because of the large numbers of interactions taking place.

The access and recovery of marine data for time series analysis should be given high priority. Long-term data gathering and time series analysis is necessary to study the effect of climate change on the marine environment. Besides monitoring, these long-term surveys should include process studies to gain a better understanding of the underlying concepts that determine the reaction patterns of the key species within the system.

Research on probable response of relevant organisms to climate change is needed. Being important elements of the food web, the responses of species of the biological environment of fish to climate impacts will be crucial for the productivity of commercial fish stocks.

Research on the effects of invasion in the context of community and ecosystem interactions is needed. Invasive species are becoming more frequent in European coastal waters, but the dynamics of such invasions are poorly recorded and understood.

Research on the impacts of ocean acidification on marine biota and their physiology, is needed. This need is especially strong on biological productivity and the offspring of fish, as they are most vulnerable. Process studies, experimental work and field studies should be integrated into biogeochemical, circulation and climate models for the evaluation of the future impacts of ocean acidification.

Needs related to fishing impacts

Development and application of adaptive measures to climate change are needed. Information on the evolution of fish in the marine environment, the change in genetic diversity and adaptation patterns is scarce.

Monitoring and evaluation of suitable areas for spatial closure (Marine Protected Areas (MPAs)) is needed.

Recovery strategies for heavily exploited species have to be determined and evaluated.

Research is needed on sustainable exploitation and appropriate fish stock management that maximises the adaptability of fish stocks to environmental changes.

Need for detailed information about the ecology of important marine species, their life cycles, migration patterns, their biological background and their interaction with the biotic and abiotic environment. The ecosystem approach to fisheries management requires insight into the infrastructure of fish stocks and their functioning. **Further development of advanced ecosystem models and multidisciplinary research** is necessary to improve the detection, prediction and forecasting methods for the response of the ecosystem to climate change and to allow effective management and the sustainable use of resources.

4. THE ROLE OF CULTURAL POLICIES AND EDUCATION

4.1. Introduction

According to the World Bank's Independent Evaluation Group (IEG), the reported number of natural disasters worldwide has been rapidly increasing in recent decades, from fewer than 100 in 1975 to more than 400 in 2005 (IEG World Bank 2007). The IEG is careful to state that the "degree to which climate change, itself a contributing factor in the increase in natural disasters, has been helping to accelerate the effects of disasters is not yet adequately understood". But the overall trend of an increase in natural disasters is clear enough.

What is the relevance of this for the EU, and in particular for its policies in the fields of culture and education?

4.1.1. Culture

In essence, the increase in the frequency and virulence of natural disasters - especially floods and windstorms - presents a major threat to European cultural heritage, both movable and immovable. Although the protection of cultural heritage is mainly exercised at the national or even regional level, Article 151 of the EC Treaty specifies that the Community shall supplement and support national actions aimed at the "conservation and safeguarding of cultural heritage of European significance".

The EU has already taken a number of initiatives to provide a common response to natural hazards. These need to be better adapted to the goal of protecting cultural heritage (see below), which is normally not their primary aim.

4.1.2. Education

In compulsory education especially, governments must decide how to integrate the issue of Climate Change into curricula. There are two aspects here: one is fundamentally pedagogic and aims to explain to pupils what Climate Change is about; the second is more concerned to encourage changes in behaviour geared towards reducing CO2 emissions. UNESCO calls these aspects "Education for Sustainable Development" or ESD. In 2007, it issued a manual on good practices in ESD[18].

It should be pointed out that school curricula are explicitly **not** an area of EU competence, so any role for the Community here must be informal. Article 149 of the EC Treaty explicitly states the Community must fully respect "the responsibility of the Member States for the content of teaching and the organisation of education systems and their cultural and linguistic diversity".

4.2. Community Policy to Safeguard Natural Heritage

Floods are the most frequent natural disaster and they are having an increasingly adverse impact, especially in cities. They can destroy historic buildings or cause considerable damage to moveable objects of historic value. Strong winds and storms are the second greatest source of damage.

[18] UNESCO, 2007: http://unesdoc.unesco.org/images/0015/001524/152452eo.pdf

Recent examples of such phenomena include the Central European Flood of 2002, which caused damage to the World Heritage medieval bridge in Písek (Czech Republic) and the Zwinger Chateau in Dresden. The Great Storm which raged through France in December 1999 knocked down more than 10,000 trees in the park at Versailles Palace which were more than 100 years old[19].

The EU is providing financial support to a small number of ongoing research projects on climate and cultural heritage. "Noah's Ark", for example, aims to "research, predict and describe the effects of climate change on Europe's built cultural heritage over the next 100 years"[20]. The project takes into account not only short-term "disasters" but also long-term effects of climate change on buildings, which in some cases will be positive (postponing natural decay).

4.2.1. Existing Community Instruments

The Community Civil Protection Mechanism (CCPM), established in 2001, supports and facilitates mobilization of emergency services to meet the immediate needs of countries struck by sudden disasters. The mechanism is intended to protect human life and property, including cultural heritage, in the event of major emergencies. It includes a "Monitoring and Information Centre" (MIC) located in Brussels.

Under recent Directive 2007/60/EC on the assessment and management of flood risks, Member States should undertake preliminary flood risk assessments by December 20011[21]. The overall purpose of the legislation is to reduce the negative consequences of floods for "for human health, the environment, cultural heritage and economic activity".

Directive 2007/2/EC, also called the "INSPIRE Directive", requires Member States to make their map and other spatial data services inter-operable for a number of uses. This should facilitate the creation of maps of cultural heritage at risk.

However - despite the existence of these instruments - a study drawn up for the Parliament's Culture Committee in 2007 concluded that "the issue of protection of cultural heritage from natural hazards has not been properly accommodated either in EU legislation or in national laws, by-laws or other documents, except in a few countries". This is because most emergency measures are - understandably - aimed at saving human lives and fail to protect cultural heritage assets. In the event of major disasters, the response is often coordinated by police and fire services, with little expertise on the protection of cultural assets.

The 2007 study concluded that human error in the Central European Floods in 2002 resulted in a larger loss of cultural heritage than otherwise would have been necessary.

It also concluded that not enough knowledge is available on the specific implications of Climate Change for the protection of cultural heritage; in contrast to other areas where research projects are abundant.

4.2.2. Ideas for the Future

The authors of the 2007 EP study recommend strengthening the capacity of MIC as a cost-effective way to give early warnings, predict disasters and to safeguard cultural heritage on the

[19] In *Protecting the Cultural Heritage from Natural Disasters*, study carried out for the European Parliament in 2007. See: http://www.europarl.europa.eu/activities/committees/studies/download.do?file=16882

[20] http://noahsark.isac.cnr.it/overview.php

[21] http://www.europarl.europa.eu/oeil/file.jsp?id=5306072 for the relevant documents.

pan-European level. In particular, they underline the need for providing well-trained personnel for the rescue of cultural heritage assets, an area where pan-EU cooperation would seem to be especially promising. Generally-speaking, only large museums or historical sites employ specialists in cultural protection for emergencies; smaller sites do not.

They also support the drawing up of EU rules requiring all public institutions responsible for extraordinarily valuable buildings and collections (museums, archives, monuments etc) to reveal their risk preparedness in their published accounts.

It is also clear that a lot of damage can be prevented by better spatial planning and upkeep of buildings. The Structural Funds are potentially useful instruments for financing preventive measures.

4.3. The EU and Climate Change Education

For reasons explained above, the EU can play no formal role in policymaking on national curricula. It does of course provide information on its environmental policy and, more specifically, pedagogic materials aimed at teachers and pupils[22].

The major EU education and training programmes continue to fund projects (for example school exchanges of pupils and/or teachers) related to the environment. Under the Comenius action for schools, for example, one of the main themes is "Environmental Education". A cursory search through the project database reveals projects too numerous or diverse to be described here[23].

Given the increasing political importance attached to the issue of Climate Change in recent years, it is unsurprising to discover that some Member States are rethinking their curricula to accommodate Education for Sustainable Development. A recent example is France where five ministers have entrusted an inter-services committee, chaired by a university professor, to draw up a report on ESD (Brégeon et al. 2008)[24]. The report argues in favour of considering ESD a multi or inter-disciplinary activity, rather than as a separate discipline. It also recommends that ESD involve contacts with actors outside school, such as businesses or environmental associations and that it should encourage action, rather than limiting itself to a strictly academic approach.

[22] http://ec.europa.eu/environment/climat/campaign/schools/schools_en.htm
[23] Relevant database at: http://www.isoc.siu.no/isocii.nsf/projects?OpenForm&Action=COMENIUS
[24] http://www.developpement-durable.gouv.fr/IMG/pdf/rapport_developpement_durable_cle05b337.pdf

5. TRANSPORT AND CLIMATE CHANGE

Mobility is a central tenet of the European Union. European transport Policy has clearly aimed at safeguarding fairly priced and efficient mobility for people and goods as the central element of a competitive EU internal market and as the basis for the free movement of people, as enshrined in the legislative treaties. The successful completion of the European internal market, the dismantling of internal borders, and falling transport prices due to the opening and liberalisation of transport markets as well as changes in production systems and in storage have led to a constant growth in transport.

As a result of this growth in particular, the EU transport sector today is facing an unprecedented challenge, stemming above all from ever- increasing demand and its severe impact on climate change. *"Climate change and transport — much is needed but too little is happening"* - this conclusion of the European Environment Agency (EEA) in its latest report (EEA, 2008) summarizes very well the problem of the transport sector. If transport in the EU continues to move in this direction, the EU's 20/20/20 vision will be put at risk. In the light of the current political and scientific debate, it is beyond question that there is an urgent need for making European transport more sustainable and energy efficient.

5.1. The transport sector and its greenhouse gas emissions

5.1.1. The current situation

The following facts and figures, mostly taken from the above mentioned EEA report, illustrate the problem:

Transport represents about one third of final energy consumption in the 27 EU Member States. It accounts for 20%[25] of all EU-27 greenhouse gas emissions (GHG). Taking into account the estimated share of EU-27 in maritime transport[26] and international aviation[27] which are not covered by the Kyoto Protocol, this figure would amount to nearly one quarter of all EU 27 GHG emissions.

Even more worrying than the current share of GHG emissions are the developments since 1990. While the total EU-27 GHG emissions fell by -7.9%[28] between 1990 and 2005, the situation in the transport sector is different. In the same period, GHG emissions from transport included in the Kyoto Protocol increased by 27%[29]. Together with the significant increases in emissions from maritime transport (+49%) and international aviation (+ 90%) the estimated total increase in emissions from EU transport amounts to 33% from 1990 to 2005. The development in the transport sector thwarts efforts in all other sectors. Without this converse trend in the transport sector EU-27, GHG emissions would have fallen between 1990 and 2005 by 14%, instead of 7.9%.

The main problem is considered to be the major increase in demand for transport. Although vehicle technology has become more energy efficient, it is nowhere near sufficient to offset the impact of the general growth in transport. Looking at the different transport modes, the increases

[25] 990 Mt CO_2 equivalent.
[26] Estimates vary between 162 Mt CO_2 equivalent for 2005, taken from EEA 2008 and 225 Mt for 2006, taken from a study on the external costs of maritime transport carried out for the European Parliament (EP, 2007c).
[27] 126 Mt CO_2 equivalent.
[28] From 5621 Mt to 5177 Mt CO_2 equivalent.
[29] From 785 to 990 Mt CO_2 equivalent.

in GHG emissions were due in particular to growth in road transport demand. Road transport accounts for around 72% of GHG emissions from the EU transport sector (including international aviation and maritime transport).

Transport is almost fully dependent on fossil fuels[30]. In view of ever increasing oil prices, a departure from a near total dependence on fossil fuels will become more and more important for the EU's economic future.

Direct GHG emissions from aviation currently account for about 3% of EU's total GHG emissions. They have been growing by 87% since 1990, much faster than from any other transport mode. By 2020, aviation GHG emissions are estimated to more than double from today's levels and this is before the inclusion of indirect warming effects, such as those from NOx emissions, contrails and cirrus cloud effects in the calculation[31]. Air travel becomes cheaper and cheaper for the customers, but meanwhile the environmental costs are not addressed sufficiently. The Commission estimates that without adopting GHG-reduction measures, increasing GHG emissions from flights from EU airports will by 2012 cancel out more than a quarter of the 8% emission reduction the EU-15 must achieve to reach its Kyoto Protocol target.

Energy efficiency in maritime transport is much higher than for other modes of transport. Therefore, short sea shipping in particular can be seen as a genuinely environmentally friendly transport alternative[32]. However, the forecast growth of maritime transport seems set to become more and more of a problem. According to recent calculations current world shipping emissions represent 3,9 %[33] of global fuel emissions and about 13% of all emissions from the transport sector. The external costs in terms of climate change for the EU fleet in 2006 are estimated to be around 17 billion Euros (EP 2007c, 12) Due to effects of globalisation, maritime transport is expected to grow between 2001 and 2020 by 35-45%. Current trends as regards higher speeds travelled at sea are predicted to reduce the current energy efficiency of this mode.

5.1.2. The current Policy framework for transport

For many years the European Union has been aiming at making the transport sector more sustainable. The key documents of the EU's strategy on sustainability in the transport sector are the 2001 White paper on transport Policy and its 2006 Mid-term review[34]. In both documents a list of measures was proposed to break the link between economic and traffic growth, to promote modal shift and combat the unequal growth of the various modes of transport.[35] Various important legislative measures have been adopted so far, inter alia:

- The revitalisation of the railways with the first and second rail packages already in force and a third package already adopted.
- New guidelines for the Trans-European Transport Networks (TENs) with priority for railways, inland waterways and maritime transport.

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[30] Currently petrol and diesel cover 98%, while biofuels represent less than 1% of total road transport fuel consumption. The remaining 1% is covered mainly by gas.

[31] It is estimated that the total impact of aviation on climate change is about 2 times higher than the effect of its CO_2 emissions alone, see OECD 2007, 90 and IPCC, WG III, 2007, 331.

[32] Provided that other external costs of maritime transport are also being addressed effectively. See EP 2007c.

[33] 1117 Mt CO_2 equivalent.

[34] COM(2001) 370; COM(2006) 314.

[35] The main goal of the White Paper is to stabilise the environmentally friendly modes of transports' share of the total traffic volume at 1998 levels. This purpose should be served by measures taken to revitalise rail transport, to promote sea and inland waterway transport and to promote the interlinking of all the modes of transport. In its 2006 Mid-term review the Commission announced further measures in order to achieve the formulated objectives.

- Traffic shifting programmes such as former 'Marco Polo' or the current 'Marco Polo II'.
- the adoption of the new 'Eurovignette' directive.

The integrated energy and climate change strategy (20/20/20) as agreed at the European Council meeting in March 2007 deals with transport mostly outside the current European emissions trading scheme (ETS). As yet, there is no binding sector specific target for transport envisaged at the EU level. Transport will be subject to binding targets at Member state level. Within this Council strategy there is however a mandatory target for the use of 10% biofuels by 2020.

5.1.3. Future prospects

Despite of the various measures adopted by the EU after the publication of the White paper on Transport, it is still unclear if - in the mid term - the growth trend in transport's GHG emissions can be stopped, let alone reversed. This depends on the effects of the already adopted measures as well as on economic growth to which the growth of transport is very closely linked. For 2010 the figures are estimated to be more or less the same as for 2005 (+26% CO_2 emissions from the transport sector compared to 1990.) The EEA's projections for 2020 (EEA 2008) see transport's emissions at 1091 Mt CO_2 equivalent[36].

Assuming that additional policy measures which are currently discussed or envisaged will have the desired effect, there could be a GHG reduction from 26% down to 19% above the 1990 levels. However, there will still be a large gap in view of the targets of the European Council of March 2007 or the even more ambitious goal of the Bali roadmap. Depending on the target chosen, additional reductions between 50 and 165 Mt CO_2 equivalent are necessary in the transport sector (EEA 2008, 10).

According to the EEA it will not be possible to achieve the above-mentioned ambitious CO_2 reductions without limiting transport demand. Significant technological improvements are indispensable but they will not be sufficient. Further far reaching policy measures will be necessary.

Higher incomes and/or falling transportation prices lead generally to a shift to faster, more energy intensive modes of transport and due to faster speeds, to ever increasing travel distances. A clear example is changes in travel patterns resulting from the emergence of low cost airlines (LCA).[37] This trend can be observed worldwide (from walking and bicycle use, to public transport to private cars, and from there to air transport). Taking into account that many countries are hardly motorised yet and that in other countries the auto fleet is growing very rapidly (e.g. from 50 million vehicles in 1950 to 580 million vehicles in China), the above-mentioned trend seems likely to have a significant impact on the forecast increase in transport energy use worldwide.[38]

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[36] Compared to 990 Mt of 2005 and assuming an average growth of 15% in transport volumes corresponding to the rates between 1990 and 2005 (excluding international air and maritime transport).

[37] By reducing the cost of air travel, mobility was encouraged in the EU. Citizens with lower incomes, who previously could only afford to travel using land modes of transport (car, train or bus) or, perhaps, did not travel at all, can now afford to travel by air as prices are far cheaper. Almost 60% of the passengers travelling with LCAs are new passengers. Travel patterns are changing (e.g. weekend trips by plane for shopping): the travel distance per trip and by passenger is increasing, see (EP 2008a, 37 et seq).

[38] The global perspective of transport and climate change as well as projections of transport energy consumptions are very well illustrated in the Transport chapter of the latest IPCC report 2007 (IPCC, WG III, 2007) http://www.ipcc.ch/ipccreports/ar4-wg3.htm

5.2. How to face the challenge?

More and more political and scientific attention is being devoted to addressing the challenges presented by the transport sector in view of its negative impact upon climate change, in order to identify possible solutions and policy options. A broad variety of potential Policy measures are currently being discussed.[39]

5.2.1. Study on "Energy and environmental aspects of the transport policy"

In 2007 the European Parliament's Committee on Transport and Tourism commissioned a study on "Energy and environmental aspects of the Transport Policy". The aim of the study was to provide background information for the Committee's own initiative report on Sustainable European transport policy, dealing particularly with the impact of transport on climate change[40]. The study is divided into two parts. Part one provides an analysis of recent data, scientific literature and policy documents revolving around transport sector GHGs, energy consumption and atmospheric pollution. The second part is dedicated to an assessment of the most promising policy measures, above all, in view of cost effectiveness and feasibility. The study identified measures for the following eight policy clusters.

Policy clusters	Measures	Descriptions
Technological improvement (vehicles and fuels)	Reduction of CO_2 emissions and fuel consumption	Compulsory targets for CO_2 emissions from cars (120g/km) and vans (175 g/km) by 2012, including through Emissions Trading Schemes for car manufacturers
	Increased efficiency in the automotive sector	Reduction of vehicle weight and resistance factors; efficiency requirements for automobile air conditioning systems
	Labelling scheme for tyres	Standards to measure tyre rolling resistance 2008
	Labelling scheme for car fuels	New CO_2 labelling scheme for amended car fuels efficiency directive (1999/94EC)
	R&D on efficient vehicles	Support for project to develop more efficient vehicles
	Improved fuels	Development of the second generation of biofuels and alternative fuels able to reduce CO_2 and air pollution emissions
Charging and taxation	Road vehicle taxation reform	Passenger car taxes linked to CO_2 emission levels
		Fiscal incentives to encourage the cleanest LDV classes
		Inclusion of land transport in CO_2 emissions trading
	Charging for Interurban Roads	Application of 'Eurovignette' Directive (1999/62) and its amended version (Directive 2006/38/EC)
		Attention to congested corridor and sensitive areas (i.e. Alpine region)
		Internalisation of external costs of transport
	Road charging in urban areas	Congestion charging, value pricing, road tolls and HOV lanes
	Tradable mobility credits	Tradable permit schemes among car drivers in urban areas
Long-distance travel (passengers and freight)	Rail interoperability	Improving the seamless movement of trains across Europe, on both high-speed and conventional rail networks
	Harmonised regulation systems	Providing fair competition for rail operators across the EU
	Rail efficiency	Increasing technical unit efficiency of rail travel
	Rail passenger services quality	Stimulating rail usage by increasing quality (rolling stock, ICT, ticketing, etc.)
	Intermodal facility for passengers	Developing service integration by mode (train, air, maritime, road) and journey (long/short-distance)
	Intermodal facility for freight	Intermodal loading units and freight integrators. Freight facility incentives to offset the capital costs of providing rail freight handling and operating facilities
	Rail capacity	Improving rail capacity by using advantage technology in key corridors (metropolitan areas) and rail bottlenecks

[39] JEGTE, 2006 or OECD 2007.

[40] The report (A6-0014/2008; Rapporteur: Gabriele Albertini) was adopted by the European Parliament on 11 March 2008. http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2008-0087&language=EN&ring=A6-2008-0014

Policy clusters	Measures	Descriptions
Liveable cities	Improved public transport services	Systems providing high-quality PT service and convenient light-rail transit on urban corridors
	Regulation, incentive effectiveness	Policy changes to encourage transport service competition, innovation and efficiency
	Park and Ride facilities and access to PT	Providing convenient parking at transit and rideshare stations
	Walking and cycling facilities	Strategies for improving bicycle transport and walking conditions
	Transport Demand Management	Developing car sharing and car pooling services as a substitute for private vehicle ownership and encouraging ridesharing
		Commuting and school travel planning that encourage more efficient transport modes (shift from car to public transport and environmental modes)
	Integrated planning	Land use, environmental and transport integration, reduction of urban sprawl, encouraging LEZ (Low Emission Zones)
ICT (Information and Communications Technology)	Real-time and pre-journey information	Real-time road traffic and PT travel information; travel planning systems to optimise use of combined modes of transport
	Teleworking/teleconferencing	Use of telecommunications as a substitute for business and commuter travel
	Telebanking/teleshopping	Use of telecommunications as a substitute for physical travel
	Research and Development	Application and technology including Galileo programme
Eco-friendly behaviour	Eco-driving	Strategies for improving driving behaviour, energy efficiency and traffic safety among drivers
	Demarketing of cars	Campaign to demarket cars to change public attitudes and develop environmental certification (ecolabels)
Logistics	Logistics management (integrated supply chain)	Strategies to improve the efficiency of freight transport and storage
	City logistics (freight distribution centres and regulation)	Strategies to improve the efficiency of freight distribution in urban areas
	Increased load factor	Strategies to optimise the load capacity of freight vehicles
Air and Maritime	Operation rules for ports	Rules on pilotage, cargo handling, stevedoring
	Marco Polo Programme	Modal shift, catalyst and common learning actions
	Vessel traffic monitoring	Monitoring System to prevent illegal discharges at sea and help in identify ships and their environmental performance
	Single European Sky	Management of air traffic, thereby facilitating further cost reductions and demand growth
	Environmentally differentiated charges at terminals	Differentiating terminal fees and charges according to the level of pollutants emitted/discharged and noise produced, mainly by ships and aircrafts

Source: European Parliament 2007d.

Furthermore, the following recommendations were made in response to the need for effective measures:

- To focus on the most critical transport modes, in particular Road transport
- To focus on the most critical parts of the transport system, namely
  - congested urban und metropolitan areas
  - key inter-urban corridors where a concentration of trade and traffic flows can be identified
  - environmentally sensitive areas
- Avoidance of un-coordinated approaches through a sophisticated policy mix, combining mutually supportive policies and containing three main areas
  - technological improvements (new technologies and alternative fuels)
  - economic instruments (pricing and taxation)
  - soft and eco-friendly measures
- Policy plans with well designed implementation times; giving priority to halting the modal shift towards road transport by applying effective pricing policies was seen as the most promising short term measure.

5.2.2. Policy Mix: Focus on key measures

As mentioned above there is the urgent need for a sophisticated Policy Mix combining mutually supportive policies. Out of the broad variety of promising measures a small, non exhaustive list of key elements in the above mentioned Policy mix will be discussed in the following section.

5.2.2.1. Road freight transport, fair prices and modal shift

Given the existing levels of GHG-emissions, its share of transport demand and its predicted growth compared to other modes of transport, the road transport sector (passenger and freight) is generally considered as the main target for policy action. A first important step would be to deal with the road freight sector.

In May 2006 the new 'Eurovignette Directive'[41] for road freight transport was adopted**.** Apart from harmonisation of rates in all Member States and uniform methods for calculating infrastructure costs, the new directive places far greater emphasis on the 'polluter pays' principle. It provides for greater differentiation between charges, taking account of environmental aspects or congestion, and consequently provides the Member States with an instrument for traffic management. In certain regions, additional toll charges may be levied in order to tackle the problem of environmental damage, including poor air quality, or to invest in more environmentally friendly modes of transport, such as railways. The full application of this directive is however not obligatory. Only a handful of Member States are partially in line with the application of distance-based charging schemes for HGV as suggested by the "Eurovignette" Directive: Austria, Czech Republic and Germany are applying some elements of "user pays" and "polluter pays" principles. Due to the short time that the new HGV pricing systems have been in place, the impacts of the HGV pricing regimes cannot yet be analysed in detail. However some trends in those countries towards reducing empty trips, and increasing load factors, as well as faster fleet renewal, thus making road transport more energy efficient per kilometre have already been noticed, in particular in Germany.[42]

Clearly, this approach could be reinforced through the full application of the existing legal framework in all countries, as well as by some further adjustments[43] to the 'Eurovignette' directive. Allowing the full integration of external costs in the road transport sector[44] seems by far the most important step. The current Directive obliges the Commission to present by not later than 10 June 2008, a generally applicable, transparent and comprehensive model for the assessment of all external costs, including environment, noise, congestion and health-related costs, to serve as the basis for future calculations of infrastructure charges. This is to be accompanied by a strategy for the gradual implementation of the model for all modes of transport.

For this reason, the so-called IMPACT study was carried for the DG TREN of the European Commission. The study led to a Handbook on estimation of external costs in the Transport sector (CE Delft 2007), as part of the study. It provides an overview of the range of the unit values calculated by different studies for all different external cost categories of road transport and also all other modes of transport. According to this Handbook external costs arising from road freight

[41] Directive 2006/38/EC of 17 May 2006.

[42] See: EP 2008b.

[43] Such as: highly differentiated tariffs on the basis of weight of vehicle, vehicle axles, emission class, time and specific sections of infrastructure in order to reflect environmental, accident and congestion costs, higher rates during peak periods and lower rates during off-peak periods in particular in sensitive areas, extending tolls to heavy vehicles > of 3,5 tonnes, extending tolls to encompass step by step the entire network

[44] The full internalisation of external costs is not yet allowed by the directive. The revenues of user charges or tolls may generally not exceed the infrastructure costs.

transport are substantially higher than those from road passenger transport; they vary greatly according to vehicle type, route and traffic time/situation, they are on average higher than its infrastructure costs. Furthermore, the overall costs from road freight transport exceed the contribution it makes to government revenue via payment of taxes and charges.

In view of climate change costs road transport accounts for the following exemplary values taken for Germany:

Road Transport - Climate change costs[45]
(in €ct/vehicle-km)

	Passenger car	***Heavy duty vehicle (HDV)***
	Unit costs (bandwidths)	*Unit costs (bandwidths)*
Urban, petrol	0.67 (0.19 - 1.2)	(-)
Urban, diesel	0.52 (0.14 - 0.93)	2.6 (0.7 - 4.7)
Interurban, petrol	0.44 (0.12 - 0.79)	(-)
Interurban, diesel	0.38 (0.11 - 0.68)	2.2 (0.6 - 4)

Source: CE Delft 2007, page 103.

Regarding road transport in particular, it is very often argued that external costs related to greenhouse gases are already fully internalised in Europe because of the relatively high taxes on fuels and vehicles. However, the IMPACT study states that:

*"(...) the transport sector, including passenger car transport, is expected to contribute its share to reach the short and medium term goals for CO_2 reduction in the European Union. If internalisation of external costs is to be used as a policy instrument to further improve the fuel economy of the European fleet, these external costs need to be internalised as an additional levy on fuels, vehicles or kilometres driven. In this context just regarding existing excise duties as yet internalising external climate costs will not contribute towards reaching the goal of reducing CO_2 emissions in the transport sector" (*CE Delft 2007,83).

Taking into account all external costs in road transport, the Handbook has calculated the following values:

Road transport - total external costs[46]
(in €ct/vehicle-km)

		Passenger car	***Heavy duty vehicle (HDV)***
		Unit costs (bandwidths)	*Unit costs (bandwidths)*
Urban	Day, peak	38.4 (8.4 - 63.9)	107.3 (33.7 - 187)
	Day, off-peak	7.9 (3.5 - 13.3)	34.8 (22.5 - 67)
	Night, off-peak	8.6 (4.1 - 14.8)	40.6 (28.2 - 80.9)
Interurban	Day, peak	14.1 (1.7 - 26.7)	54.4 (13.3 - 109)
	Day, off-peak	4.1 (1.7 - 6.7)	19.4 (13.3 - 39)
	Night, off-peak	4.2 (1.8 - 6.8)	20.3 (13.6 - 39.9)

Source: CE Delft 2007, page 103.

The Handbook stresses that *"there is consensus at scientific level that external costs of transport can be measured by best practice approaches and that general figures (within reliable bandwidths) are ready for policy use*" (CE Delft 2007, 13).

[45] Exemplary values for Germany; for passenger car: medium vehicle (1.4-2 L), EURO-3, for HGV: truck >32 t, EURO-3, based on valuation for 2010.

[46] The following cost categories were taken into account by the IMPACT study: Noise, Congestion, Accidents, Air pollution, Climate change, Up- and downstream processes, Nature and landscape, Soil and water pollution.

The stepwise internalisation of the above external costs for road freight would contribute significantly to promoting modal shift policies towards more sustainable modes of transport as an important priority[47] of the White Paper on Transport. It could also create an additional source of revenue for the difficult completion[48] of the 30 TEN-T Projects, many of them focussing on rail and inland waterway infrastructure.

5.2.2.2. Passenger cars, technological improvements, consumer behaviours and preferences

Today, passenger cars are responsible for 12% of all EU CO_2 emissions. The efficiency of fuel consumption in passenger vehicles has improved, however a more sustained effort by the motor vehicle industry is needed. It seems clear that European and Asian vehicle manufacturers will not reach the target of an average emission of 140g CO_2/km by 2008/2009. The new Commission proposal for a regulation[49] with a binding new target of an average emission of 130 g CO_2/km is even more challenging for the industry. Together with other measures a target of 120g CO_2/km by 2012, as adopted by the European Council in June 2006, is envisaged.

Technically, even less than 120g CO_2/km are easily feasible. Several energy efficient cars are already on the market. The consumer preferences however pose problems to sell them. The lack of progress in CO_2 reduction is due to greater weight, more powerful engines and additional equipment required by consumers for comfort and safety (e.g. air conditioning). Moreover, in recent years there has been an increase in sales of off-road vehicles (SUVs) and other high emitting cars. Technology improvements on the supply side still have a huge potential for energy reduction, if they are applied to increase fuel economy and rather than to increase engine power. Nevertheless, the EEA has pointed out that the necessary GHG reduction in the transport sector cannot be achieved by technical measures alone (EEA 2008). Managing and, in particular, limiting the demand for private car use will become more and more important.

Stronger fiscal incentives directly related to CO_2 emissions will play a key role to make cars more energy efficient. They might also help to make smaller and lower powered cars more attractive for the customers. These incentives can also been seen as push factors for the industry to achieve faster technological improvements. The Commission has recently proposed a system of penalty premiums for those car manufacturers not meeting the 130 g/km target by 2012. Other possibilities are also being discussed, such as the development of an EU CO_2 emission trading scheme for car manufacturers as proposed recently in scientific literature[50] or so called tradable Mobility credits.[51]

Furthermore, a series of complementary measures is needed to address the demand side. Better practises in car marketing and advertising, making the car labelling directive more effective, clearer and more consumer friendly, awareness rising through information campaigns on saving

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47 The European Environment Agency has nevertheless pointed out that the desired effects of Modal shift policies have to be analysed in detail and case by case, as in some cases they can increase the volume of e.g. rail transport without decreasing the volume of road transport, increasing thereby the total environmental burden. The ASSESS report on the mid-term review of the White Paper also draws attention to the fact that modal shift can be very useful but can be no substitute for further action on the current and future modes of transport that are growing, such as road transport, passenger vehicle transport and aviation (see: (EEA 2006, 20) and (EC, ASSESS 2005, 106 et seq.).

48 EP 2008c.

49 COM(2007)856. The proposal consists of a binding target of 130g/km average GHG emissions for new cars sold in the EU, combined with a system of penalty premiums in case that a manufacturer has not reduced the average GHG emission below 130g/km of its cars sold after 2012.

50 See Dudenhöffer 2007, p. 20-24.

51 See EP 2007d , page 69.

fuel as well as ecodriving are estimated to have an effect. Nevertheless, changing consumer habits without the right price signals will be very difficult.

Increasing car ownership[52] in the EU does not only lead to a shift away from public transport but is also seen by EEA as a symptom of a lack of genuine public transport alternatives. But even assuming area-wide public transport alternatives in the future, private cars will nevertheless continue to determine our mobility. The European Union should therefore develop a clear long term vision of how it understands viable individual mobility that is independent of the conventional energy sources in the future. The question should be what technical options are to be used for a new generation of propulsion systems (e.g. Hydrogen/fuel cells, electric vehicles); when will they be able to be mass produced; and how the respective transition periods will be organised in the meantime. As with all other options - also for hydrogen, fuel cells or electric vehicles - lifetime GHG impacts are of particular importance. They depend above all very much on how hydrogen or electricity is produced[53].

5.2.2.3. Biofuels

There is growing scientific evidence that Biofuels are not as "green" as the prefix "bio" might suggest. In particular biofuels of the so called 'first generation' are no longer seen as the first class solution to the climate change problem as experts until recently thought. On the contrary, they are considered more and more as part of the problem. According to recent studies, the net GHG emission reduction is supposed to be only roughly around 50% of conventional fuels they replace. The intensive growing of high yield bio energy crops can be responsible for the release of other Greenhouse gases like nitrous oxide through fertilisers and for the loss of carbon sinks through deforestation. Taking into account also the growing pressure on land, water, soil, biodiversity and food prices, caused by monocropping for biofuels, the overall benefits of first generation biofuels production could even be negative. The overall GHG mitigation potential and also the sustainability of the second generation of biofuels[54] seems to be much better. However, the entire production chain of those biofuels has to be assessed also more carefully in view of overall sustainability[55]. The development of clear and strong sustainability criteria for biofuels is therefore indispensable.

EEA analysis shows that EU Member States are still far from meeting the current biofuel targets. Furthermore, compared to the use of biomass for electricity production, biofuels seem to have a less favourable cost effectiveness, as stated recently by the OECD[56].

5.2.2.4. Liveable cities and a new culture for urban mobility

Eighty per cent of European population live in urban areas. A total of 40% of all transport-related CO_2 emissions are produced in European cities - particularly from passenger cars. Hence, in urban areas there is high potential for more energy efficiency and GHG reduction in transport. Promoting the shift towards sustainable transport will not only result in relief for congested and polluted cities but also contribute significantly to reduce GHG emissions. The European Commission has recently published a green paper on urban mobility.[57] Although urban mobility falls mostly under the principle of subsidiarity, the EU can contribute to sustainable urban

[52] 25% between 1995 and 2005
[53] See Transport chapter of the latest IPCC report (IPCC, WG III, 2007, 345 et seq.).
[54] For example: conversion of ligno-cellulosic sources like grasses or wooden material into biofuels.
[55] A concise overview of alternative fuels is provided in EP 2007d, page 23 et seq. See also: EEA 2008, page 20 et. seq.
[56] OECD 2007, pp. 81-88.
[57] Green Paper: towards a new culture for urban mobility - COM(2007)0551.

mobility, in particular through research and best practice programmes as well as through EU funding.

High-quality public transport and its financing

According to UITP (Union Internationale des Transports Publics) public transport emissions per passenger/km are 3,24 to 8,71 lower compared to the use of a private passenger car when public transport is used (UITP 2008, p. 3). At peak times public transport have an even greater advantage[58]. But public transport must provide a realistic alternative to private car use. It has to be tailored to the needs of the customers. The continuous improvement of public transport systems is needed in order to attract more and more citizens. The denser the network, the higher the frequencies, the number of connections and their speed, the better comfort, information, safety, and reliability, the more users can be convinced to use public transport. Well developed connections with the surrounding areas seem also to be of particular importance. To reach these targets sometimes significant investments are needed. Congestion charging systems like the one in London can help bearing the cost by using the revenues for investments in urban transport. Some cities have already followed the London example, others are thinking of doing so. Such congestion charging would furthermore also provide an effective tool for transport demand management of private cars in the cities with other positive side effects like air pollution reductions.

Better Integration of cycling and walking into urban mobility.

It is estimated that half of all car trips in the EU-15 are of less than 6 km, which is about half an hour cycling distance (JEGTE, 2006)[59]. Cycling and walking could offer real alternatives for many of these trips. A dedicated cycling policy could therefore be very successful in reducing car traffic in cities[60]. The use of bicycles depend on many factors, however a well designed and above all safe network of cycle paths seems to be of utmost importance for high cycling rates in cities. In Denmark or the Netherlands, the cycling rate is more than ten times higher than the rate in France or the United Kingdom[61]. Moreover, compared to other modes of transport, the construction of infrastructure for cycling and walking is much more cost efficient. At the same time they are producing high mobility gains.

Sustainable urban transport plans

The above mentioned could be incorporated, together with a broad variety of complementary measures in so called sustainable urban transport plans (SUTP). Those transport plans should be tailored to the respective needs of each urban area and also integrate the surrounding areas. They should define and set mid- and long term objectives and deadlines for switching to more sustainable forms of urban transport. They should also encourage the development of mobility management systems as well as integrated land use and transport planning in order to reduce urban sprawl. The EU could contribute through the development of guidelines for such SUTPs. As a first step, the adoption of SUTPs at a decentralised regional/local level as well as measuring CO_2 emissions on a regular basis could be made obligatory by the EU in all major urban areas.

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58 Up to 27 times according to the German VDV.

59 UITP estimates even that 70% of all car trips are less than 4 km in the EU (UITP 2008).

60 For example, between 1999 and 2002 the city of Odense (population: 150 000) was the Denmark's official national cycling city. The project developed 50 initiatives to promote cycling. During the project, the citizens of Odense made 35 million new cycle journeys (around 25 000 per day), half of which were previously made by car. Copenhagen is another example of a very cycling friendly city. See EEA 2006; OECD 2007.

61 In Denmark 936, in the Netherlands 848 km/person/year, compared to 75km in France and the United Kingdom, and only 20 km in Spain (EEA 2008, p. 31).

5.2.2.5. Maritime transport and Aviation

As outlined above, these two sectors have grown constantly and considerably in recent years. This growth will continue and higher GHG emissions will result. The question of the carbon footprint of Aviation and maritime transport is therefore deserving of greater attention.

In order to address this issue for maritime transport and in order to maintain its energy efficiency advantages, a mix of technological improvements and operational measures was recently suggested[62]. Technological improvements in maritime propulsion and auxiliary plants, as well as operational abatement measures are estimated to have a reduction potential of 20% for old and 30% for new ships. A problem, undermining the energy efficiency advantage of maritime transport is seen in the increasing vessel speed, as a reaction to the highly competitive globalised transport market. Speed reductions together with loading optimisations are therefore seen as complementary measures. The same goes for environmental differentiation of port dues (based, for example on CO_2 engine standard or fuel type). The European Parliament has recently called for incorporating maritime transport into the Emission trading scheme[63]. The setting-up of an adequate CO_2 monitoring system would be a first and important step in this direction.

Although airlines have cut their fuel consumption by 1%-2% per passenger-kilometre in the last ten years, the growth in air transport means that GHG emissions from aviation are increasing much faster than those from any other transport mode. Without further action, aviation emissions are likely to be more than double their present levels by 2020. The incorporation of aviation into the emission trading scheme (ETS) is currently being prepared under the co-decision procedure. In its first reading, the European Parliament approved the Commission's plan to include the aviation sector in the EU Emission Trading Scheme. It went even further by reducing the number of ETS-authorised emissions for aviation and by removing the derogation for flights between EU and third countries to be covered one year later than intra-EU flights. In EP's opinion all flights should be covered by ETS as from 2011. While the Commission had proposed capping ETS allowances for CO_2 emissions at 100 percent of aircraft operators' average annual emissions during 2004-2006, the EP aimed at reducing the number of ETS-authorised emissions for aviation to 90 percent. Including Aviation in the ETS would also boost technological improvements as regards airframes or engines, with an estimated overall GHG reduction potential up to 50% by 2050, compared to today's production standards.

The gradual creation of the single European sky (adopted in 2004), in particular the future creation of Functional Airspace Blocks (FAB), as well as the modernisation of the European air traffic control infrastructure (SESAR) will contribute to enhancing the energy efficiency of aviation. More sophisticated air traffic management (ATM), as well as more efficient use of routes is expected to significantly reduce flight times, fuel use and climate impacts[64]. The European Parliament has recently also called for emissions-based differential take-off and landing charges at airports.

Finally, consumers already have the possibility of voluntary participation in carbon-offsetting

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62 EP 2007d, page 21 et seq.

63 European Parliament resolution of 12 July 2007 on a future maritime policy for the European Union: a European vision for the oceans and seas (A6-0235/2007 Rapporteur: Willi Piecyk) http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2007-0343+0+DOC+XML+V0//EN

64 The Commission estimates this reduction at 4.8M tonnes of CO2 per year.

programmes[65], which calculate individual flight emissions and then 'neutralise' them through financial participation in projects which save approximately the same amount of carbon dioxide. This seems a step in the right direction[66]. However, apart from direct emissions, other impacts of aviation (NOx emissions, contrails or cirrus cloud coverage) on climate change will also have to be addressed in the future.

5.2.2.6. Research and technological development

Improving the energy efficiency of drive trains, aerodynamics, enhancing fuel efficiency and sustainability of biofuels, and reducing vehicle loads through the use of lightweight materials are all considered to have significant reduction potential for all modes of transport. Apart from technological improvements, as already mentioned above, this goes for example for hybrid drive trains in urban buses and in delivery vehicles / heavy duty vehicles operating mostly in urban areas. Railways also have a significant GHG reduction potential although they are already more energy efficient than most other modes of transport (assuming current average loading factors). Reducing aerodynamic resistance, and train weight, as well as the development of a new generation of regenerative braking systems with energy storage devices onboard, are deemed to be promising. Several EU research programmes covering all transport modes are currently being conducted.[67] The successful transformation of this research into applied technology as well as strengthening research capacity seem even more important when taking into account future strong transport growth in developing countries. These technological improvements could mitigate the impact of this growth. However, the IPCC states very clearly:

"Even with all these improved technologies and fuels, it is expected that petroleum will retain its dominant share of transport energy use and that transport GHG emissions will continue to increase into the foreseeable future. Only with sharp changes in economic growth, major behavioural shifts, and/or major policy intervention would transport GHG emissions decrease substantially." (IPCC, WG III, 2007, 336)

[65] Various airlines have established carbon-offsetting initiatives, http://www.enviro.aero/Carbonoffsetting.aspx Furthermore there are several other carbon-offsetting initiatives, like for example **myclimate** http://www.myclimate.org/?lang=en **greenmiles** http://www.greenmiles.de/ or **atmosfair** http://www.atmosfair.de/index.php?id=9&L=3

[66] Some of these initiatives calculate carbon-offsetting also for other modes of transport.

[67] The budget for EU funded research in Transport for the period 2007 – 2013 is over €4 100 million. For further information, see the homepage of the DG TREN http://ec.europa.eu/research/transport/index_en.cfm

6. REGIONAL DEVELOPMENT AND CLIMATE CHANGE

6.1. The Strategic Guidelines for the Structural Funds 2007-2013: starting point in the regions' fight against climate change

A recent Eurobarometer survey[68] revealed that 84% of the persons questioned take the view that regional policy must in future address the major challenges facing Europe, the most pressing of which, as indicated by 85% of those surveyed, is climate change. The scale and complexity of the phenomena linked to climate change call for a redoubling of our efforts and more effective coordination of approaches to the problem at all levels: European, national, regional and local. In its recent Green Papers[69] on climate change and sustainable energy, the European Commission has set major goals for the Union with a view to meeting these challenges. Although achieving those goals will primarily be a Community matter – involving coordination of European Union (EU) policies as a whole – the regions still have a key role to play. Geographically close to all the actors concerned, the regions are the arena in which practical choices can be made in favour of renewable energies and high-performance energy technologies.

If European and international climate-related goals are to be met, it is important, therefore, to combine top-down measures (Kyoto objectives, European directives) with a bottom-up approach (decentralised measures) and so provide qualitative and quantitative support for the efforts to achieve the goals in question. Improved energy efficiency and greater use of eco-energies are likely to have many favourable spin-offs for the economy and regional development: in addition to greater security of supply and ecological benefits, they will generate new investments, products and jobs.

Since successful energy projects are very often regional and local projects, this experience can in turn influence European energy policies. The new cohesion policy programmes launched in January 2007 offered a perfect opportunity to strengthen this process.

The European Commission's strategic guidelines for the period 2007-2013 repeatedly emphasise just how closely energy challenges are bound up with the efforts to achieve the Lisbon and Göteborg goals. The guidelines call for priority to be given to investments which help the EU meet its Kyoto commitments and advocate that the issue of the intensive use of traditional energy sources should be addressed in three ways:

- by improving energy efficiency and the widespread adoption of development models based on low energy use;

- by supporting the development of renewable energies which may constitute an asset for the EU and thus strengthen its competitive position whilst contributing to its efforts to achieve the goal, by 2010, of producing 21% of its electricity from renewable sources;

- by concentrating investments in the area of traditional energy sources – and, more particularly, in the regions covered by the 'Convergence' objective – on projects to develop networks to offset market shortcomings.

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[68] Eurobarometer survey conducted in the 27 Member States in January 2008.

[69] *Adapting to climate change in Europe – options for EU action*, COM(2007)354 final, and 'A European Strategy for Sustainable, Competitive and Secure Energy', COM(2006)105.

Between 2007 and 2013, the European Commission will inject € 9 billion into energy-related projects[70]: € 4.8 bn for renewable energies and € 4.2 bn for energy efficiency (in particular in housing) and energy management measures. Of that total budget, 54% will be invested as follows: 20% in biomass, 12% in solar energy, 13% in geothermal, hydroelectric and other forms of energy and 9% in wind energy. The remaining 46% will be invested in energy efficiency. This means that, for the regions covered by the 'Convergence' objective, investment will be five times higher over the period 2007-2013 than it is at present. For regions covered by the 'Competitiveness' objective, investment will be seven times higher.

In addition, € 63.8 bn will be invested in support for research and development, including a significant proportion to assist projects which encourage research into renewable energies.

As regards investment in housing-related energy matters, the regulation[71] governing the European Regional Development Fund (ERDF) stipulates that this type of expenditure is exclusively reserved for Member States which joined the EU after 1 May 2004. Nevertheless, the President of the European Commission, José Manuel Barroso, recently announced[72] that the Commission intended to submit a proposal amending that regulation. Negotiations are continuing with the legal service of DG Regional Policy with a view to revising the implementing regulation so that the scope of the measure can be extended to cover the old Member States, both as regards the construction of new buildings and the energy-related refurbishment of existing housing stock.

On 25 February 2008, at the European Commission's annual conference on *'Regions for Economic* Change', five projects were awarded the *RegioStars 2008*. In the category '*Energy efficiency and renewable energies*', the prize was awarded to ENERGIVIE (Alsace, France). This regional programme encourages demand for equipment linked to renewable energies. It helps to improve professionals' skills in the areas of solar energy, wood energy and construction and supports projects dealing with low-energy buildings. It also covers studies into biofuels, biogas and geothermal energy. The *autonomous, floating ecological desalination plant* (southern Aegean, Greece) was singled out for special mention. Under this project, a floating platform has been developed which uses renewable energy sources to produce drinking water intended for the Greek Islands.

6.2. The contribution of the Structural Funds 2000-2006 to the fight against climate change

A study[73] entitled '*The use of sustainable and renewable energies in the context of structural policy 2007-2013*' was drawn up at the request of the Committee on Regional Development to encourage public debate on the fight against climate change and assess the contribution of the Structural Funds.

Against the background of the energy situation and energy policies, data has been compiled in the 15 Member States concerned by the 2000-2006 programming period. Although the results vary very substantially from one country to another, the analyses reveal the modest share of

[70] Announcement made by Danuta Hübner, Commissioner with responsibility for regional policy, at a press conference on 20 February 2008.

[71] Regulation (EC) No 1080/2006.

[72] Announcement made on 7 February 2008.

[73] *The utilisation of sustainable and renewable energies in the context of structural policy 2007-2013*, study drawn up on behalf of the European Parliament, (EP, 2007e). Copies of this study are available on request from: ipoldepb@europarl.europa.eu.

expenditure earmarked for renewable and sustainable energies, roughly 1.16% of total expenditure under the 2000-2006 operational programmes. In the light of the analyses carried out by other authors in countries in which awareness of energy-related issues is very high, it should be emphasised that the initial forecasts were at least three times higher than the level of actual expenditure.

An analysis of the quantitative data highlighted the predominance of measures and projects concerning renewable energies over those dealing with energy efficiency. The obvious explanation for this result is the higher profile of renewable energies, which makes them more attractive for political decision-makers.

The quantitative analysis also emphasised the importance of the energy-related expenditure earmarked for small- and medium-sized enterprises (SMEs). A few years ago, energy-related expenditure was devoted to improving infrastructure and resources were primarily set-aside for the public sector or major energy production and distribution companies. The majority of financial resources for sustainable and renewable energies are now channelled to SMEs, which have developed new technologies, new services and new products.

For its part, the qualitative analysis showed that some Member States had succeeded in integrating energy-related objectives into broader economic development objectives. Energy and technological innovation, energy and rural development, energy and the construction industry: these are only a few examples of the scope which still exists for new initiatives in this sector, new initiatives which would improve the quality of programming.

The situation of the new Member States is of particular interest, given the share of Structural Fund resources allocated to them and the lack of experience of their managing authorities. Here again, however, the situation varies from one Member State to another: the Baltic States earmark more than 5% of the funding they receive for energy-related projects, a much higher proportion than the other countries. An analysis of the various documents reveals a growing interest in the issue of energy efficiency, one which chimes in with local needs regarding plant conversion and energy-saving in the construction sector, and in the use of agricultural and forestry biomass.

An analysis of the 2000-2006 programming period and of the prospects for the forthcoming period in the old Member States reveals similarities of approach among groups of countries. The countries of central Europe (Austria, Germany) seem to have the most dynamic energy and environmental policies. The United Kingdom has geared its efforts primarily towards businesses, whilst the Scandinavian countries have tended to pay closed attention to the needs of rural areas. France and the Benelux countries have employed more limited approaches focusing on specific issues (public buildings). Finally, with a few exceptions the Mediterranean countries have had problems in incorporating into their programming ambitious and coherent goals concerning sustainable and renewable energy.

An analysis of the national strategic reference frameworks (NSRFs) for the period 2007-2013 reveals welcome developments, however. First of all, the volume of financial resources earmarked for sustainable and renewable energies seems to be increasing, strategic approaches are more readily identifiable, and, finally, a larger number of regions have singled out sustainable and renewable energy as a priority or a specific measure. The question is whether these favourable developments will be carried over into the national and regional operational programmes and reflected in the volumes of funding committed and utilised.

A study of the NSRFs reveals striking disparities between Member States. Some are innovative, whilst others have problems in shedding traditional ways of thinking. The financial data

available shows an increase in the level of energy-related expenditure, but the overall amount involved is still low. The goal of earmarking 5% of Structural Fund resources for sustainable and renewable energies seems to be receding; a more modest goal of 3% would be more realistic.

Finally, the identification and analysis of 15 good practices have highlighted the strategic role played by sustainable and renewable energies in the development of a locality and its undertakings. For the latter, sustainable and renewable energies can become a significant technological asset, when it comes to both reducing costs and improving competitiveness and developing new commercial opportunities.

6.3. Climate change in the recent work of Parliament's Committee on Regional Development

Over the last two years the Committee on Regional Development has drawn up a series of reports and opinions which bear witness to its consistent standpoint in favour of integrating the problem of climate change and incentives to use sustainable and renewable energies into overall policy approaches.

6.3.1. Fourth report on cohesion[74]

This report identifies, *inter alia*, the main challenges which the EU will be required to address in coming years. These include climate change, which will be reflected in the increased vulnerability of certain areas to natural disasters and an increase in energy prices. A range of repercussions can be expected and it is clear that they will require responses tailored to individual regions.

Moreover, MEPs take the view that in the future the EU will face an increasing number of challenges which will have a major regional impact and energy- and climate-related issues will be among the most pressing.

6.3.2. Mid-term review of the Sixth Community Environment Action Programme[75]

The Committee on Regional Development calls for increased cooperation at Community level in the area of disaster prevention, as outlined in the Sixth Environment Action Programme, and stresses the need for an effective regional and interregional cooperation mechanism in the area of the prevention of natural disasters, i.e. the ability to provide a response, management and mutual assistance in the event of such a disaster. Moreover, MEPs urge the Commission to include disaster prevention among the objectives of its climate change strategy.

They also recommend that the regional dimension should be taken into account in the implementation of the Sixth Environment Action Programme, especially in actions concerning the mitigation of and adaptation to climate change.

6.3.3. Conventional energy sources and energy technology[76]

This document draws attention to the great potential which the remote and outermost regions have as regards renewable energies, by virtue of their geographical and climatic features, and calls for this potential to be exploited to the full.

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74 Own-initiative report, Ambroise Guellec, A6-0023/2008.
75 Opinion, Rumiana Jeleva, PE 398.438v01-00.
76 Opinion, Aguilar Francisca Pleguezuelos , PE 388.628v01-00.

The MEPs also urge the Commission, the Member States and the regions to utilise effectively the opportunities offered by cohesion policy to invest in new energy technologies, using both renewable energy sources and sustainable fossil fuels (zero emission power plants).

6.3.4. European strategy for sustainable, competitive and secure energy - Green Paper[77]

The MEPs emphasise the fact that a common energy policy should give absolute priority to energy efficiency and to renewable and decentralised energy sources. They highlight the key role played by local and regional authorities and the role they could play in connection with measures which concern them, for example the energy performance of buildings. They also call on local and regional authorities to use the most energy-effective infrastructure and services, in particular for outside lighting systems and public transport networks.

The Committee on Regional Development stresses that integrated, constant support should be given to local and regional authorities as regards energy efficiency and measures relating to sustainability under all Community funding programmes, such as the Structural Funds, the Seventh Framework Programme for Research and Intelligent Energy for Europe, and in connection with the activities of the EIB.

6.3.5. Thematic strategy for the urban environment[78]

MEPs take the view that the implementation of an integrated approach to the management of the urban environment encompassing '*urban transport*' should be used as a criterion for the granting of Structural Fund subsidies and EIB aid.

6.4. European networks promoting renewable energies in the regions

The following short list in no way claims to be exhaustive. The networks singled out have been selected because they take a comprehensive approach to energy- and environment-related issues and, above all, because a large proportion of their activities focus on the regions.

6.4.1. European Renewable Energy Council (EREC)

The EREC[79] is an umbrella organisation for industries, associations and research institutes active in the areas of bioenergy, small hydropower and geothermal, ocean, solar and wind power. Its objectives are as follows:

- to act as a forum for exchanges of information;
- to provide information and advice on renewable energies for political decision-makers at local, regional, national and international levels;
- to launch policy initiatives to create reference frameworks for renewable energy sources;
- to promote European technologies, products and services on global markets.

With a view to achieving these objectives, the EREC works on a series of projects and regularly organises conferences, workshops and events.

[77] Opinion, Oldrich Vlasak, PE 378.707v01-00.
[78] Opinion, Gisela Kallenbach, PE 371.922v01-00.
[79] For more information go to: http://www.erec-renewables.org/.

6.4.2. Energie-Cités

Energie-Cités[80] is an association of European local authorities which promotes sustainable energy policies. It has 150 members in 24 European countries, representing more than 500 towns and cities. Its objectives are:

- to strengthen the role, powers and skills of towns and cities in the area of energy efficiency, the promotion of renewable energy sources and environmental protection;
- to provoke debate on matters relating to energy, the environment and urban policy and put forward proposals;
- to develop the initiatives put forward by towns and cities by means of exchanges of experience, transfers of know-how and the organisation of joint projects.

6.4.3. FEDARENE

The European network FEDARENE[81] represents local and regional organisations which implement, coordinate and facilitate energy and environmental measures. At present, more than 50 innovating regions from 17 Member States work together in the network and exchange good practices and know-how.

6.4.4. ISLENET

ISLENET[82] is a network of European island authorities which promotes renewable energy sources and sustainable management. It actively promotes the implementation of renewable energy strategies and projects, which have a major impact on local economic development whilst employing a sustainable management approach.

[80] For more information go to: http://www.energie-cites.org/.
[81] For more information go to: http://www.fedarene.org/.
[82] For more information go to: http://www.europeanislands.net/.

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