COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 10.1.2007
SEC(2007) 7

COMMISSION STAFF WORKING DOCUMENT

Limiting Global Climate Change to 2 degrees Celsius
The way ahead for 2020 and beyond

Impact Assessment Summary

{COM(2007) 2 final}
{SEC(2007) 8}

1. INTRODUCTION

The 2005 Communication "*Winning the Battle against Global Climate Change*" outlined the challenges ahead in tackling global climate change. The European Council and Parliament have both confirmed the objective to limit average global temperature increase to a maximum of 2°C compared to pre-industrial levels. The European Council expressed the need to further explore strategies that can deliver the necessary emission reductions and requested the European Commission to deepen its analysis. This Communication responds to this request.

2. TAKING STOCK OF THE RECOMMENDATIONS OF THE 2005 COMMUNICATION

The EU is projected to reach its Kyoto Targets. Projections of existing policies for the EU-15, show that greenhouse gas (GHG) emissions will only be 0.6 % below base-year levels in 2010, well above the collective reduction target of 8 % for 2008-2012. Additional measures can reduce the gap by more than half and the Kyoto mechanisms and the removal through sinks will deliver the remaining effort. This underlines the importance of the implementation of all existing and additional measures.

A second phase of the European Climate Change Programme (ECCP) started in October 2005. The European Commission has since come forward with a proposal to include aviation in the EU emissions trading scheme (EU ETS) and will put forward a communication on emissions from cars, a proposal on carbon capture and geological storage (CCS) and a Green Paper on adaptation during 2007. The review of the EU-ETS has started and the 7th Framework Programme for research (2007-2013) increases the budget for environment, energy and transport to around € 8 bn.

International cooperation has been stepped up. Regular policy dialogues with key countries such as China, India and the US take place. Technology co-operation, for instance on CCS, has increased and the 7th Framework Programme will stimulate this further. Access to finance for low carbon technologies is expanded, e.g. through the Global Energy Efficiency and Renewable Energy Fund.

3. RECENT SCIENTIFIC FINDINGS ON CLIMATE CHANGE

New research confirms that the climate is actually changing and there are indications that these changes have accelerated. The 10 warmest years on record occurred after 1990. Today's atmospheric methane and CO_2 levels are unmatched during the last 650 000 years. Acceleration in sea-level rise has been observed. A large share of the ecosystem services will be adversely impacted such as reduced glacier cover and increased ocean acidification, with potential dramatic impacts on the environment.

Uncertainty about the impacts of climate change is reduced. Critical temperature levels that risk triggering large scale disruptions are well within the range of projections for this century, confirming the need to limit temperature increase to 2°C. Recent studies point to an increasing risk of exceeding the 2°C objective with GHG concentrations levels beyond 450 parts per million volume CO_2 equivalent (ppmv CO_2 eq.).

4. COSTS OF INACTION FOR EUROPE

Scientific methodologies and data gaps still do not allow for a complete analysis of the costs of inaction. The on-going PESETA study, coordinated by the Joint Research Centre will fill some of the knowledge gaps for the EU. The project considers impacts on agriculture, human health, tourism, river basins and coastal systems.

Preliminary results indicate that *grain crop productivity* is projected to decrease in Southern Europe and increase in Northern Europe. *Health effects* include increased summer heat related mortality and morbidity (illness). The reverse is the case for winter. Preliminary results indicate that without acclimatisation the increase in heat related deaths by the end of the century could be larger than the reduction in cold related deaths. Damages due to sea-*level rise* in the EU are very significant if no adaptation occurs. Adaptation reduces costs in the medium term up to 50 % and in the long run by more than 70 %. The results show the benefits of timely adaptation using measures like dike construction and beach nourishment. However, costs will remain considerable.

Extreme weather events such as major floods are projected to increase. Preliminary results for two river catchments draw consistent conclusions. Estimated total damages of a 100-year flood are projected to increase with up to 40 % for the Upper Danube and up to 14 % for the Meuse catchment. Preliminary results also indicate that the zone with excellent conditions for beach tourism currently located around the Mediterranean, will shift towards the north, but conditions in spring and autumn improve in the Mediterranean. The extent of the impacts will depend on the level of adaptation by tourists to these changes in weather conditions.

5. BENEFITS OF CLIMATE ACTION IN OTHER POLICY DOMAINS

Air quality: Strong inter-linkages exist between climate change and air pollution policies. Reducing CO_2 emissions generates substantial reductions of other air pollutants, in particular sulphur dioxide, Particle Matter and nitrous oxides. Reducing CO_2 emissions by almost 22 % compared to baseline in 2020 reduces impacts on human health, projecting benefits of between € 27.8 bn and € 48.1 bn and substantially reducing costs of other air pollution objectives. Similar or larger co-benefits are anticipated in developing countries.

Energy security: Recent developments have again drawn attention to the volatility of energy markets. The G8 has appealed to take action forward on climate change and clean energy. This comes at a period that will see investments in the energy system at an unrecorded scale, estimated by the International Energy Agency at just over US$ 20 trillion up to 2030 sector. This creates a window of opportunity. Choosing a low-carbon pathway is cheaper when replacing or extending existing infrastructure. The World Bank estimates that significantly de-carbonising power production in non-OECD countries requires incremental investments of up to € 25 bn per year. None of the technologies identified by the IEA that could bring emissions back down are expected to have an incremental investment cost of more than € 20 per tonne of CO_2 emissions, when fully deployed.

Energy security has also become a major concern within the EU. Projections by the PRIMES model see oil imports rise by around 25 % between 2000 and 2030 and natural gas imports more than double. The March 2006 Green Paper "*A European Strategy for Sustainable, Competitive and Secure Energy*" puts forward three policy options that are critical to achieve energy security and climate change objectives: energy efficiency, renewable energy and CCS.

The projected impacts of increased energy efficiency and renewables penetration are substantial, reducing CO_2 emissions compared to 1990 with 21 % by 2020. By 2020 oil and gas imports would be reduced by more than 15 % compared to the business as usual case. CCS provides another option for low carbon technology. Projections by the POLES global energy model foresee an important role for CCS capturing around 30 % of CO_2 emissions of fossil fuel power plants by 2030, in the EU but also global, offering energy security benefits.

Employment: The impact assessment for the Biomass Action Plan estimated that this plan could create in the EU some 250 000 to 300 000 additional jobs. Wind Energy is also a rapidly growing sector in Europe already employing for instance 120 000 people in Germany, Denmark and Spain alone. The European Trade Union Confederation is undertaking a study on climate change policies and employment. Intermediate results show that most studies available agree that the overall impact of climate policies on employment can be positive.

Soil Fertility: Soil organic matter is important in the carbon cycle. Soil is at the same time an emitter and a major store of carbon. Considerable carbon losses from soils have recently been measured in the UK. If these findings will be confirmed across the EU, this would be a serious concern that requires further action. Uncertainty is high and further research is needed. The Thematic Strategy for Soil Protection aims at tackling the loss of organic matter from European soils, contributing to maintaining soil fertility and keeping or increasing carbon levels in the soil.

6. INTERNATIONAL STRATEGIES TO REACH CREDIBLE EMISSION REDUCTIONS BY 2050

Emission profiles

Recent research confirms that a stabilisation towards 450 ppmv CO_2 eq. has a 50 % chance of attaining 2°C objective. GHG concentrations are already close to 430 ppmv and increase yearly by about 2 ppmv. To meet the 2°C objective, GHG concentrations will need to reduce to 450 ppmv CO_2 eq. in the long-term, after exceeding this level in the coming two to three decades. This is a so-called "overshooting" scenario, similar to the 500 ppmv CO_2 eq scenario in the Stern Review.

The European Commission has carried out an impact assessment for such an overshooting scenario using the POLES global energy model (partial equilibrium model), the GEM E3 model (general equilibrium model) and DIMA (Forestry model). The "overshooting" scenario gives a 50 % chance to reach the 2°C objective and require global emissions to peak between 2015 and 2020. Land use change emissions, mainly from deforestation, are responsible for around 20 % of global emissions and should be reversed by 2020. GHG emissions from other sources would need to decrease by around 25 % by 2050 compared to 1990 levels.

Up to 2050 the POLES model was used to give insights into future technologies. Cost estimates were generated up to 2030. The Baseline Scenario includes recent higher estimates for energy prices and the EU-ETS with a low price of € 5/tonne CO_2. In the emission reduction scenario, global GHG emissions peak by 2020 and then decrease by 25 % by 2050 compared to 1990.

Energy efficiency policies are implemented in all countries motivated by concerns on energy prices. Developed countries are assumed to take on emission reduction targets. The energy intensive industries participate in a continuously further integrating global carbon market.

Developing countries are exposed to a lower carbon price in the beginning, simulating the limited penetration of carbon prices at firm level through instruments such as the Clean Development Mechanism (CDM). By 2030, carbon price differences become small as a result of a better regulatory framework also in developing countries, except for low income countries. Other sectors do not participate in the global carbon market but policies with similar effects are assumed in developed countries. In developing countries, only energy efficiency policies are implemented.

Projections of GHG emissions

Under the baseline scenario, global GHG emissions are projected to increase by 86 % in 2050 compared to 1990. In 2020 developing countries' emissions would surpass those of developed countries.

Under the emission reduction scenario, emissions of developed countries in 2020 are already 18 % below those in 1990 and 32 % in 2030. For the EU-25, the reduction compared to 1990 levels would be 21 % in 2020 and 36 % in 2030. Developing countries' emissions would peak between 2020 and 2025. By 2030 global emissions are only 10 % above 1990 levels.

Technical feasibility

Significant changes to the energy system are necessary. Limiting energy consumption through energy efficiency is the most important measure. The residential and tertiary sectors experience the largest savings and are sensitive to efficiency standards. Efficiency rates in fossil fuel power plants also increase as a result of the replacement of conventional coal power plants with more advanced technologies. By 2030 the EU would import 60 % less coal and 20 % less imports oil and gas than in baseline.

The power sector remains a key sector for reducing emissions**.** Renewables other than hydro are projected to experience a 24-fold increase between 2005 and 2050. CCS will become an important global transition technology, although coal use is projected to decrease. Coal plants are replaced by advanced coal technologies. Natural gas partly offsets coal, reaching a maximum of 33 % of global power production in 2025. Nuclear energy increases its share in electricity generation but in absolute terms it remains close to the deployment in the baseline.

Costs and emissions trading

In the POLES projections, the global carbon price per tonne of CO_2 reaches € 37 by 2020 and € 64 by 2030. Costs, as a result of investments in low carbon technologies, are estimated at less than 0.5 % of global annual GDP up to 2030. Reduction targets of up to 30 % in 2020 and and 50 % in 2030 would trigger carbon trading, achieving cost-effective emission reductions on a global scale. Attaining the developed countries' targets with trading reduces the global cost by three quarters.

The costs as a result of additional investments in low carbon technologies, are not to be confused with the impacts on economic growth. The GEM E3 model for the entire economy was utilised to assess the impact on growth. With an emissions profile compatible with the 2ºC objective, world GDP still almost doubles in the coming 25 years. In 2030, world's GDP growth is around 0.19 % lower compared to baseline in annual terms. Depending on the allocation of reduction commitments the impact on national GDP will vary. The GDP change in annual terms for the EU region is larger than the global one, in the range of -0.19 % by

2020 to -0.24 % in 2030. The large developing countries, though without reduction commitments in 2020, also observe a small reduction in their GDP compared to baseline, (ranging from -0.06 % in Brazil and China to -0.1 % in India in annual terms) due to trade effects.

The assessment shows that reducing global emissions to a level that accomplishes the 2°C objective is feasible if participation is broadened. All countries need to improve energy efficiency and reduce emissions in the transport, residential and tertiary sectors. Energy intensive sectors, in particular the power sector, need to gradually integrate into a global carbon market ensuring cost efficiency. The group of developed countries needs to take on reduction targets of around 30 % in 2020 compared to 1990 increasing to 40 - 55 % by 2030 and have full access to the global carbon market. Such target would result in domestic emissions reductions in developed countries 2020 of 20 %. Developing country emissions would need to start to peak between 2020 and 2025 and decrease afterwards.

Domestic EU emissions reductions

Reducing emissions in the EU would be beneficial for energy security and air pollution and would stimulate competitive technologies. The impact of autonomous reductions targets in the EU of 21 % and 31 % by 2020, without broad participation, was assessed with the GEM-E3 model. Although such autonomous target would send an important political message, global emissions would only be reduced by less than 5 % compared to baseline. Even without broad participation there will need to be access to CDM, acting as a "safety valve". Without access to the CDM, carbon prices will be 8 to 11 times higher. With access to CDM, attaining the targets would be considerably less costly than the reduction scenario with global participation.

Full access to the CDM would lead to limited reductions internally with limited co-benefits, but such reductions and co-benefits could be achieved by flanking EU energy policies.

Reversing deforestation

The role of emissions from deforestation will be key to meet the 2°C objective. The Dynamic Integrated Model of Forestry and Alternative Land Use (DIMA) analysis the drivers for deforestation. For this impact assessment, a financial incentive per ton of CO_2 was introduced in the model that is similar to the price projected in the POLES model at regional level. The projected impact is large, showing a reversal from net source to net sink by 2020. Reversing trends in such a manner will be challenging.

The introduction of a financial incentive to reverse deforestation requires careful analysis. The financial incentive introduced in the DIMA model could become astronomical if it were introduced for all standing stocks of forest to avoid its deforestation. Many issues make an incentive scheme a complex matter. Forests are degraded for different reasons and governance and tenure of forests is diverse and often unclear. A recent report by the World Bank proposes carbon financing as a tool but also points to the need for other measures such as financing for biodiversity, better monitoring and evaluation, better legislation on property rights and better planning procedures on for instance road building.

Experience exists with various incentive schemes and other approaches, but applying these experiences at the international level is difficult. One of the next steps should be to gather practical experience through pilot schemes.