EXECUTIVE SUMMARY

Global Climate Policy Scenarios for 2030 and beyond

Analysis of Greenhouse Gas Emission Reduction Pathway Scenarios with the POLES and GEM-E3 models

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Executive summary

Policy background

The European Union is committed to limiting the global temperature increase to 2 degrees Celsius above pre-industrial levels by 2100. The commitments under the Kyoto Protocol, which refer to the period from 2008 to 2012, are only a first step that will need to be followed by further action after 2012.

In March 2005, the European Commission approved the Communication 'Winning the Battle Against Global Climate Change', which underlined the need for broadening international participation in future efforts in tackling climate change. The European Council of March 2005 acknowledged this, recognising that industrialised countries will need to continue to take the lead and explore options to reduce their greenhouse gas (GHG) emissions by 15-30% by 2020. The European Council also requested the European Commission to further deepen its analysis of long term climate policies.

As a response to this request, **the European Commission published in January 2007 the Communication 'Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond'. That Communication and the accompanying Impact Assessment drew on the scenarios presented in this study.** Following the Communication, in March 2007 the European Council endorsed a 'firm independent' EU commitment to cut GHG emissions by at least 20% by 2020 compared to 1990; this target will become 30% provided that there is a comprehensive international agreement that broadens global participation and that other developed countries commit themselves to comparable emission reductions. At the same time, the European Council adopted an 'Energy Policy for Europe' supporting, among other goals, a 20% renewable energy target by 2020, improvements in energy efficiency and increases in low carbon sources which will help in achieving the required emission reductions.

Objective and approach

The objective of this report is to provide a detailed description of the scenarios, as well as the approach and hypothesis followed. The scenarios were developed with an analytical toolset consisting of the partial equilibrium energy model POLES and the multi-sectoral general equilibrium model GEM-E3. Using these two models in an integrated way allows the assessment of the technological and economic options for reducing global GHG emissions. The POLES results provide detailed insights into the response of the energy sectors to these policy measures. On this basis the direct costs involved (i.e. abatement costs and emissions trading costs) can be derived. The GEM-E3 model is used to analyse the adjustments in the whole economy (i.e. not only within the energy sectors) and the resulting impacts of the climate policy on GDP and on household welfare.

Two main scenarios were modelled[2]: a baseline scenario following a 'business-as-usual' trend and a greenhouse gas (GHG) reduction scenario that includes energy efficiency and dedicated climate change policies aiming at global emission reductions of 25% by 2050 compared to 1990 levels. Such a reduction is consistent with a pathway that will allow meeting the 2 Cº target[3]. Until 2030 only developed countries are assumed to have a binding GHG emission reduction target: the target is set to -30% by 2020 and -50% by 2030 compared to 1990 levels. Developed countries can use 'flexible mechanisms'[4] to buy emission reductions from the industry and energy sectors of developing countries.

The GHG reduction scenario takes a novel approach by not assuming a perfect emission trading system in all sectors and across all world regions. Instead, it simulates an imperfect carbon market across sectors, with

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[2] An intermediate scenario, the *reference scenario,* was developed to take into account the effects of dedicated energy efficiency policies, reflecting the increased awareness on security of energy supply. The scenario results indicate that the reductions in energy consumption can considerably lower GHG emissions compared to the baseline scenario. However, to achieve the reductions of emissions that are necessary for meeting the 2 Cº objective, a range of additional measures are required as analysed in the GHG reduction scenario.

[3] The probability of the GHG reduction scenario to meet the 2 Cº target was assessed as part of this report. The scenario (after extrapolation to the year 2100) has a 50% probability of limiting the temperature increase to 2 Cº for a climate sensitivity uncertainty range of 2.1 C° to 4.4 C° with a mean value of 3.3 C°.

[4] The term 'flexible mechanisms' refers to emission trading, joint implementation (JI) and clean development mechanisms (CDM), as defined in the Kyoto Protocol.

road transport, residential and tertiary sectors not being included in the international emission trading scheme. In addition, various clusters of countries are assumed to enter the international carbon market at different points in time, depending on their economic development. As a consequence of this stepwise entry, the abatement cost and thus the carbon value are differentiated between sectors and regions.

Results of the scenario exercise

In the baseline scenario global GHG emissions from energy use and industrial processes are projected to increase by 86% from 1990 to 2050. The share of emissions from developing countries is steadily increasing with their emissions tripling over that time period. In the GHG reduction scenario, global emissions peak around 2020 and subsequently fall to reach the target level of 25% below the 1990 emissions by 2050. GHG emissions in developed countries are reduced by 60%, while they are projected to increase by 43% in developing countries. The GHG reduction scenario also shows that the current trend of substantial releases of GHG emissions into the atmosphere resulting from deforestation could be reversed as a response to the introduction of dedicated climate change policies.

Broad participation of countries in the GHG emission reduction efforts is indispensable for realising a 2 C° target pathway. Without participation by developing countries, a reduction only in the developed countries would lead to an increase of global emissions of 33% between 1990 and 2050 because of the increased emissions from developing countries[5].

Such a GHG reduction scenario leads to carbon prices in the range of 30 - 40 €/tCO_2-equivalent in developed countries by 2020. In developing countries, the industry sectors would face a gradual increase in the price of carbon by 2020. This will take place before those countries adopt binding emission caps and will be initiated by an increasing demand from developed countries through instruments such as the Clean Development Mechanism (CDM). **By 2030, all global industrial sectors would face the same carbon price of around 65 €/tCO_2-equivalent**, except in the low income developing

[5] This is computed by adding emissions from the GHG reduction case for developed countries and the baseline scenario for developing countries.

countries where the carbon price is expected to amount to one third of the global level.

Triggered by the carbon price and energy efficiency standards, global energy production and consumption will undergo significant changes:

Energy savings throughout all sectors are one of the key elements in the reduction scenario, delivering up to half of the overall emission reductions that are needed to move from the baseline to the GHG reduction scenario. Large reductions in final energy consumption are projected in the residential, tertiary and transport sectors. Minimum efficiency standards for, e.g. electrical appliances, buildings and cars, are vital for exploiting the energy reduction potential in these sectors, which will then be enhanced by the carbon price. Regarding industry and power generation, efficiency improvements are mainly mobilised by the carbon price. Despite the improvements in energy intensity and the savings realised compared to a baseline development, global energy consumption is nevertheless expected to rise further in the GHG reduction scenario compared to current levels, driven by the growth in developing countries.

Reducing the carbon intensity of energy consumption by switching to low or non-carbon fuels and capturing CO_2 emissions, particularly in the power sector, is the second key element. The power sector is very responsive to the introduction of a carbon price due to the availability of low carbon alternatives and the importance of fuel costs. Despite a continuous rise in electricity consumption, emissions are expected to fall drastically to almost 20% of their 2005 levels by 2050. Coal-based electricity generation is reduced by almost two thirds by 2050 (compared to 2005). In particular, renewables, and also nuclear power, increase their shares and, beyond 2020, the capturing and storing of CO_2 emissions will gain importance; by 2050, the large majority of the remaining fossil fuel based electricity is projected to be generated in plants containing a capturing process.

The GHG reduction scenario results show that there is a feasible pathway for limiting the global temperature increase to 2 ºC. The average annual direct costs needed for the restructuring of the global energy system, calculated with the POLES model, would be 0.4% of GDP for the period 2013 - 2030. For the economy as a whole the annualised change in global GDP

computed with the general equilibrium model GEM-E3 is estimated to be -0.19% in 2030, compared with the baseline scenario. For the EU-27 region this figure is -0.24%.

The use of 'flexible mechanisms' is central for limiting the cost of an ambitious climate change policy. Over the period 2013 - 2030 substantial trade flows result from the assumed stepwise entry of various regions into the global carbon market and the binding commitments of developed countries. Developed countries are projected to purchase approximately one quarter of the emission reductions needed to meet their target of a 50% reduction of GHG emissions by 2030. If it is assumed that there is no trade between developing and developed countries, direct costs would almost triple. The importance of flexible mechanisms becomes evident also in a number of sensitivity analyses assuming unilateral action by the EU. If a unilateral EU target of 20% was to be met only through domestic GHG emission reductions in 2020, the GDP change would be five times higher than meeting a similar target with the use of flexible mechanisms.

Besides limiting the damage of climate change, a GHG reduction pathway brings additional benefits, such as increased energy security. In the EU, for example, imports of fossil fuels would decrease due to energy savings and changes in the fuel mix. By 2030, the EU would reduce its import levels by 60% for coal and 20% for oil and gas compared to the baseline. Other benefits, though not quantified in this study, include lower air pollutant emissions, which is particularly beneficial for economies in transition and for developing countries.