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TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Towards a comprehensive climate change agreement in Copenhagen

- Extensive background information and analysis

-PART 1-

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Executive summary

This staff working document assesses different policy options for main issues under negotiation for a new international climate change agreement to be reached in Copenhagen in December 2009. It builds on earlier analysis been undertaken for two earlier Commission communications on international climate change policies[1] and especially on then Spring Council conclusions 2007 setting the overall objectives for the EU's climate policy.

In this working paper the following **key issues** have been assessed:

– Comparability of individual GHG emission reduction targets for developed countries;

– LULUCF accounting rules;

– Surpluses of Assigned Amount Units from the 1st commitment period (2008-2012) and the implications for future targets;

– Appropriate action to be undertaken by developed countries to achieve their target and by developing countries to deviate substantially from baseline;

– Further development of the global carbon market ;

– Reduction in emissions from deforestation and forest degradation in developing countries;

– Addressing international maritime transport and aviation;

– Assistance for appropriate mitigation and adaptation by developing countries through finance and technology;

Individual GHG emission reduction targets for developed countries

A selected number of key criteria which are currently under international discussion for setting comparable and effective reduction targets for developed countries for the period after 2012 have been analysed, i.e. GDP/capita, GHG/GDP, GHG emission trends since 1990 and Population trends.

The analysis clearly shows that using a single indicator for the allocation of individual country efforts leads often to disproportional costs or gains for single countries. Using GDP per capita as the sole criterion can lead to very high costs in countries with high incomes that are relatively efficient. At the same time, using GHG intensity of the economy or population trends for those economies that have a high GHG intensity or a decreasing population trend, respectively, while their GDP per capita is relatively small, leads to high costs for those economies.

[1] Winning the battle against global climate change (COM(2005) 35 final), and Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond (COM(2007) 2 final).

Therefore, it is unlikely that an allocation option based on a single criterion will gain political consensus. Using a combination of criteria in order to define a target instead of a single indicator will lead to a fair outcome in terms of cost per unit of GDP.

LULUCF accounting rules

The current accounting rules for Land-Use, Land-Use Change and Forestry (LULUCF) for developed countries are temporary and will have to be decided on for the period after 2012. The working document analyses the impact of various accounting options for the accounting of LULUCF that are currently under international discussion on the amount of removals and emissions that can be reported.

In fact, four options have been assessed next to the existing accounting rules:

1. No changes to the current accounting rules. Existing arbitrary caps would be continued.

2. Based on the current regime except replacing the cap on sinks from forest management by a discount factor.

3. Accounting for the difference in annual absorptions/emissions compared to the absorption/emissions of a base year, the so called net-net approach.

4. Eliminating the impact of natural disturbance, age-class effect and indirect human-induced effects in the sector by comparing annual net absorption/emissions with the projected net absorption/emissions, using a forward looking baseline. Such a baseline is adapted over time to take into account the natural disturbance that do occur and have an impact on the absorption/emissions.

5. Full land based accounting as done at present under the UNFCCC inventories with a net-net accounting approach for all LULUCF land use categories reported under the Convention inventories.

The analysis clearly points out that the risk of large sinks credits coming into the system, potentially overwhelming the reductions needed in the other sectors, is limited for most of the options as long as absorptions from forest management are accounted for through an approach (options 2 and 4) or constrained gross-net approach through a cap or discount factor (option 0 and 1). However, from a qualitative point of view and not a mere quantitative point of view the current rules are not satisfactory because the simple capping of forest management does not stimulate and reward real additional action in this sector but merely rewards business as usual action.

The preferred option should meet criteria such as simplification, comprehensiveness in the accounting of emissions and removals in the LULUCF sectors in order to avoid leaving substantial greenhouse gases sources of emissions outside of the accounting while at the same time crediting potentially large (ensuring environmental integrity), broader coverage of managed land, and encouragement of national policies to deliver the full contribution of agriculture and forestry to climate change mitigation. Option 4 seems the one that delivers on most of these criteria. However, this approach is likely to require additional reporting efforts by Parties, especially to estimate emissions and removals from agricultural soils. Issues of compliance risks, due among other to natural disturbances, inclusion of harvested wood products, and national circumstances also need to be considered in this option.

Surplus of Assigned Amount Units and the impact on future targets

When setting targets for the 1st commitment period under the Kyoto Protocol it was assumed that the US would become a full Party to the Protocol. Targets were set in a way that a reduction of a little more than 5 % would have been achieved. However, with the US not being a Party, these reductions will not be realised. Instead, there might be significant surplus of national emission budgets (so called Assigned Amount Units or AAU). This working paper assesses the potential implications for the -30% target for the group of developed countries as surplus AAUs are allowed to be banked into the period after 2012.

Surplus AAUs from the period 2008-2012 constitute a significant risk for the environmental effectiveness of the reduction targets for the period after 2012. Should this not be taken into account when setting the overall ambition level, the -30% reduction target compared to 1990 by 2020 might result in real emission reduction of only -26% or even less compared to 1990 by 2020 depending on the number of actual surplus AAUs.

Appropriate global action to be undertaken

Actions in the energy system and industrial sector on a truly global scale are crucial to ensure that the 2°C limit can still be met.

In developing countries, around two third of the reduction potential compared to baseline in the energy system and in the industrial sectors comes from measures typically related to efficiency improvements, that can be realised at no or low cost in the short and mid term because of the significant energy savings. On a global level energy efficiency improvements represent around 50% of the actions until 2020. They might require substantial upfront investments which might pose a cash flow problem to those countries where private sector does not have the necessary financial/loan capacity.

Energy efficiency improvements are by far the single most important action until 2020. But there is no single silver bullet technology. Next to energy efficiency improvements, there are other cost efficient opportunities of using low-carbon energy sources (renewables & nuclear), to switch to lower carbon content fossil fuels, and gradually develop and implement CCS for all large remaining point sources on a global scale, especially those newly build after 2020.

Further development of the global carbon market

Three options for the further development of the carbon market have been assessed:

i) a gradual expansion of the global carbon market;

ii) no global carbon market and

iii) a perfect global carbon market.

The analysis shows that a gradually developing global carbon market decreases costs significantly to reduce GHG emissions, also if targets are 'fairly' allocated. Without a gradual development economic costs to fight climate change could become very high.

The gradual expansion can be supported by using offsetting mechanisms that are environmentally effective. In future, these should only compensate costs for reductions that are over and above low cost mitigation options. Offsetting mechanisms can as such provide an incentive for reductions that are not credited. These new types of offsetting mechanisms would only credit reductions that go beyond a reference emission level that reflects own appropriate mitigation actions in developing countries.

Reduction in emissions from deforestation and forest degradation (REDD) in developing countries

The EU's policy objective is to halve emissions from gross deforestation by 2020. By 2030 net forest loss has to be reversed, reducing to zero the emissions from net deforestation. It has been assessed at what costs this objective can be met and what the impact will be on other land uses, most importantly agriculture.

The analysis shows that it is essential and cost efficient to reduce gross tropical deforestation by at least 50 % by 2020 compared to current levels, and that it is feasible and affordable as well. Not reducing emissions from deforestation would lead to a significant cost increase for additional action required in the energy and industry sectors amounting to an increase of costs of around three times the cost of action on REDD.

The analysis shows that increased demand for bio-energy may turn out to be an important driver for afforestation and reforestation. However, in the short term, reducing emissions from deforestation is more cost efficient than increased afforestation or reforestation. Thus, the deforestation of areas for the purposes of biomass extraction for bio-energy production needs to be minimised.

If crediting of REDD actions would be fully allowed for offsetting purposes, then targets for developed countries would need to be made much more stringent. In the above assessment they would need to be cut further from -30% to -38% compared to 1990 by 2020.

To achieve the REDD objectives through providing a performance-based financial incentive, an estimated € 18 billion in 2020 (2005 prices) will be necessary, if leakage can be limited to a regional scale. Leakage is an important cost factor for the efficiency of REDD policies.

In addition to the expected population growth, it will be crucial to address pressures on agriculture stemming from climate policies, i.e. REDD and increased demand for bio-energy, through increasing agricultural productivity in a sustainable way.

Agriculture itself offers a substantial mitigation potential, often through intensification of the agricultural production. Such practices will need to take into account local ecosystem characteristics and respect water, soils, biodiversity. They could include shifting from traditional grassland based livestock production systems to landless ones, progressive switch from low input and rain-fed agricultural practices towards higher input and sustainable irrigation systems as well as improving soil management practices in croplands and grazing lands areas.

Increasing agricultural productivity in a sustainable manner will require support for capacity building and rural development in developing countries.

Addressing international maritime transport and aviation

Since 1990, emissions growth from these sectors has been high and is expected to continue to rise, even when action on GHG emissions is undertaken. So despite the need for global emissions to peak by 2020, reductions from these sectors to below 1990 levels by 2020, as discussed for developed countries, are unrealistic.

Due to the internationally mobile nature of emissions from these two sectors, and risks of profound carbon leakage, it is preferable to address these emissions globally. Therefore, meaningful global goals should be set to limit the further growth of emissions from these sectors and those goals should be achieved by implementing an appropriate global sectoral approach. However, if such approach can not be agreed within ICAO and IMO by the end of 2010, those emissions should be counted towards national totals under the Copenhagen agreement. The latter should ensure comparable action in all developed countries.

Incremental costs related to a global pathway to meet the EU's 2ºC objective

Additional costs in the energy system are estimated at € 152 billion in 2020 (2005 prices) of which € 81 billion can be attributed to mitigation costs in developed countries. € 71 billion comes from mitigation costs in developing countries, of which, however, € 38 billion are compensated through carbon credit trades in the carbon market.

In practice this means that significant shifts in investment flows need to be realised, with some sectors/technologies receiving much higher investments compared to baseline (e.g. energy efficiency) and some much lower (e.g. primary energy production).

To achieve the REDD objectives through an incentive-based approach, an estimated € 18 billion in 2020 (2005 prices) will be necessary, if leakage can be limited to a regional scale. Not taking this action would see a little more than twofold increase in costs in the energy and industry sectors because of additional action to be taken in these sectors.

Global net incremental investments to reduce global emissions in the energy, industry and deforestation sectors need to increase gradually to around € 170 billion per year in 2020. While this represents only a small fraction of global GDP, it remains a significant injection of additional finance into the global economy, requiring significant larger investments in growth areas such as energy efficiency and renewables and reducing carbon intensive investments. It is estimated that more than half of the additional net investments (around € 90 billion in 2020) will have to be realised in developing countries.

Costs for mitigation to reduce emissions from agriculture, are estimated at an € 6.5 billion in 2020, of which developing countries represent € 5.0 billion. Significant increases in agricultural productivity will require support for capacity building and rural development in developing countries.

Assistance for appropriate own action by developing countries through finance and technology

As stated in the problem definition, further support by developed countries for developing countries action on mitigation and adaptation will be necessary. Several options have been assessed as to how such new contributions could be generated and how to determine the relative shares for the financial contribution of different countries, including i) actual contributions for Official Development Assistance; ii) actual scale of assessment for the UN budget, iii) polluters pays principle, i.e. emitted GHG emissions, which could be applied only on developed countries or on a global scale; and iv) share of total GDP.

Depending on the distribution key, the EU's contribution could range between 15 – 60 % of total funding. Again, building a composite index that reflects responsibility and capability might be the most suitable and political acceptable way forward. Furthermore, there is no doubt, that the larger the number of contributors, the higher the amounts that will be able to be mobilised, especially in view of the current economic recession.

Glossary[2]

- Assigned Amount Units (AAU) - Under the Kyoto Protocol, developed countries reduction

- The Kyoto protocol sets an absolute emission cap at country level for developed countries (QELRO or Quantified Emission Limitation and Reduction Objective). This absolute cap get translated into a total absolute amount of allowed emissions over the entire commitment period (2008-2012), called a country's Assigned Amount. This Assigned Amount is issued into a country's registry in individual Assigned Amount Units (AAUs), each representing 1 ton of CO2-equivalent emissions. These are the emission rights that can be transferred under the Kyoto Protocol's emission trading mechanism and these are also used to demonstrate compliance with a country's Kyoto Protocol target.

- Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

- Adaptation Fund - was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol. The Fund is to be financed with a share of proceeds from clean development mechanism (CDM) project activities and receive funds from other sources.

- Afforestation - Planting of new forests on lands that historically have not contained forests.

- Annex I Parties - The industrialized countries listed in this annex to the Convention which were committed return their greenhouse-gas emissions to 1990 levels by the year 2000 as per Article 4.2 (a) and (b). They have also accepted emissions targets for the period 2008-12 as per Article 3 and Annex B of the Kyoto Protocol. They include the 24 original OECD members, the European Union, and 14 countries with economies in transition.

- AWG-KP - Ad hoc Working Group on further commitments for Annex I Parties under the Kyoto Protocol. The AWG-KP was established by Parties to the Protocol in Montreal in 2005 to consider further commitments of industrialized countries under the Kyoto Protocol for the period beyond 2012, and is set to complete its work in Copenhagen in 2009.

- AWG-LCA - Ad hoc Working Group on Long-term Cooperative Action. The AWG-LCA was established in Bali in 2007 to conduct negotiations on a strengthened international deal on climate change, set to be concluded in Copenhagen in 2009.

[2] For a more extensive glossary on climate change acronyms used in the UNFCCC, see: http://unfccc.int/essential_background/glossary/items/3666.php

- Capacity building - In the context of climate change, the process of developing the technical skills and institutional capability in developing countries and economies in transition to enable them to address effectively the causes and results of climate change.

- Cap and trade - Mechanisms that set a cap on emissions and allocated a number of emission rights to entities to cover for their emissions. Those entities can use the emission rights to demonstrate compliance and can trade these emission rights among them. Examples of cap and trade system are the one set up by the Kyoto Protocol for countries with a reduction target (Annex I countries) via the creation of Assigned Amount Units and possibility to trade them via the "Emissions Trading" mechanisms. The largest private sector example is the EU Emission trading system (EU ETS)

- Carbon Leakage - That portion of cuts in greenhouse-gas emissions by developed countries (countries trying to meet mandatory limits under the Kyoto Protocol) that may reappear in other countries not bound by such limits. For example, multinational corporations may shift factories from developed countries to developing countries to escape restrictions on emissions.

- CDM - Clean Development Mechanism: a mechanism under the Kyoto Protocol through which developed countries may finance greenhouse-gas emission reduction or removal projects in developing countries, and receive credits for doing so which they may apply towards meeting mandatory limits on their own emissions.

- COP - Conference of the Parties: the supreme body of the UNFCC Convention. It currently meets once a year to review the Convention's progress. The word "conference" is not used here in the sense of "meeting" but rather of "association," which explains the seemingly redundant expression "fourth session of the Conference of the Parties."

- Conference of the Parties serving as the Meeting of the Parties (CMP): The UNFCCC's supreme body is the COP, which serves as the meeting of the Parties to the Kyoto Protocol. The sessions of the COP and the CMP are held during the same period to reduce costs and improve coordination between the Convention and the Protocol.

- Credits - Emission entitlements generated in offsetting or carbon crediting mechanisms that can be used for compliance in cap and trade systems at country or private sector level.

- Deforestation - Conversion of forest to non-forest.

- Emission rights - Emission entitlements generated in cap and trade systems. Two examples of emission rights generated through cap and trade systems are Assigned Amount Units (AAU) and EU Allowances (EUA)

- ETS - Emission trading systems are cap and trade systems set up to regulate emissions at private entity level. At present the largest ETS is the EU ETS.

- EUA - EU Allowances: The EU Emission Trading System sets an absolute emission cap for large point source emitters in the EU and allows for trade. The emission rights traded are called EU allowances.

- Flexible mechanisms - Generic terms for the 3 mechanisms under the Kyoto Protocol that allow for flexibility across borders to achieve reduction targets by Annex I parties. The 3 flexible mechanisms are 'Emissions Trading' between Parties, Joint Implementation (JI) and the Clean Development Mechanism (CDM)

- GEF - Global Environment Facility: an independent financial organization that provides grants to developing countries for projects that benefit the global environment and promote sustainable livelihoods in local communities. The Parties to the Convention assigned operation of the financial mechanism to the Global Environment Facility (GEF) on an on-going basis, subject to review every four years. The financial mechanism is accountable to the COP.

- GHGs - Greenhouse gases: the atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20). Less prevalent --but very powerful -- greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

- Global carbon market - The transfer of emission rights or credits that has the objective to be used for compliance purposes by both public and private authorities.

- GWP - Global warming potential

- ICAO - International Civil Aviation Organisation

- IEA – International Energy Agency

- IIASA - International Institute for Applied Systems Analysis

- IMF – International Monetary Fund

- IMO - International Maritime Organisation

- Intergovernmental Panel on Climate Change (IPCC) - Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.

- International carbon crediting mechanisms – Mechanisms that generate credits for emission reductions in countries or sectors that are not subject to a quantified emission reduction or limitation target. Like offsetting mechanisms, they allow for the transfer of these credits to other countries or private sectors entities in other countries for compliance with binding emission caps. More broadly than offsetting mechanisms, carbon crediting mechanisms include also those mechanisms that provide credits for emission reductions only beyond a certain target level that is more ambitious than business as usual. An example for such mechanisms is the so called "no-lose" target that rewards emission reductions below a crediting target, but does not require countries or sectors to acquire credits if the target is not met.

– JRC/IPTS - Joint Research Centre's Institute for Prospective Technological Studies, European Commission

– Kyoto Protocol - An international agreement standing on its own, and requiring separate ratification by governments, but linked to the UNFCCC. The Kyoto Protocol, among other things, sets binding targets for the reduction of greenhouse-gas emissions by industrialized countries.

– LULUCF - Land use, land-use change, and forestry. A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.

– Marrakesh Accords: Agreements reached at COP-7 which set various rules for "operating" the more complex provisions of the Kyoto Protocol. Among other things, the accords include details for establishing a greenhouse-gas emissions trading system; implementing and monitoring the Protocol's Clean Development Mechanism; and setting up and operating three funds to support efforts to adapt to climate change.

– Mitigation - In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere.

– Net deforestation – difference between afforestation and deforestation & reforestation

– Non-Annex I Parties - Refers to countries that have ratified or acceded to the United Nations Framework Convention on Climate Change that are not included in Annex I of the Convention.

– QELROs - Quantified Emissions Limitation and Reduction Commitments. Legally binding targets and timetables under the Kyoto Protocol for the limitation or reduction of greenhouse-gas emissions by developed countries.

– Offsetting mechanisms - Mechanisms that generate credits for emission reductions in countries or sectors that have themselves no emission cap and allow for the transfer of these credits to countries or sectors that have an emission cap under a cap and trade system in order to be used for compliance purposes. At present the only offsetting mechanism is the CDM that can be used by countries with a reduction target under the Kyoto Protocol for compliance and is also allowed within the EU ETS for compliance in the EU ETS. Also the proposals discussed in the US congress on a US ETS foresee offsetting mechanisms. But these also include internal ones in sectors not covered by the US ETS.

- Private carbon market - This covers a set of activities, i.e. the investment by the private sector in credit generating activities in offsetting mechanisms, the transfer of emission rights or credits as intermediates and the use of emission rights or credits for compliance purposes by private entities under an ETS.

- Public carbon market - The transfer of emission rights or credits that has the objective to be used for compliance purposes by public authorities, such as Annex I parties under the Kyoto Protocol.

- REDD - Emissions from deforestation and forest degradation

- Reforestation - Replanting of forests on lands that have previously contained forests but that have been converted to some other use.

- RMU - Removal unit: A Kyoto Protocol unit equal to 1 metric tonne of carbon dioxide equivalent. RMUs are generated in Annex I Parties by LULUCF activities that absorb carbon dioxide.

- SRES - Special Report on Emissions Scenarios: emissions scenarios used, among others, as a basis for the climate projections in the IPCC the Third and the Fourth Assessment Reports.

- Subsidiary Body for Implementation (SBI) :The SBI makes recommendations on policy and implementation issues to the COP and, if requested, to other bodies under the UNFCCC.

- Subsidiary Body for Scientific and Technological Advice (SBSTA): The SBSTA serves as a link between information and assessments provided by expert sources (such as the IPCC) and the COP, which focuses on setting policy.

- Technology transfer - A broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change among different stakeholders

- UNFCCC - United Nations Framework Convention on Climate Change.

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Organisation and timing

This staff working document gives background information to the Communication "Towards a comprehensive climate change agreement in Copenhagen". This Communication further specifies the Commission's climate change policy as outlined in the 2005 Communication "Winning the battle against global climate change" and the 2007 Communication "Limiting global climate change to 2ºC".

This Communication is a strategic initiative in the Commission Legislative and Work Programme 2009, "Acting now for a better Europe". It is a non-legislative action with the aim to further refine the EU's negotiating position towards achievement of the EU objective of limiting the average increase of global temperature to 2°C above pre-industrial levels within the mandate as defined by the European Council in Spring 2007. It is meant as an input for further discussions in order to shape a comprehensive EU position ahead of the UN Climate Change Conference in Copenhagen[3] in December 2009.

This staff working document also builds further on the analysis of two earlier impact assessments[4], and presents the results of examining different options for engaging all countries in taking further action against climate change, including investment and financing options. Work on this staff working document started in March 2008. The Joint Research Centre's Institute for Prospective Technological Studies (JRC/IPTS) was requested to further improve its global climate change mitigation models. A draft outline of the Communication and annotations to it were distributed in the Inter-service Group on the international climate change negotiations, and this group was regularly updated on the work on the communication.

The staff working document made use of several models to assess the impact on GDP and other relevant socio-economic factors of low carbon emission scenarios and certain specific elements of interest to the future international agreement on climate change.

The global POLES model was used by JRC/IPTS to analyse the impact on the energy system and industry. It assesses the mitigation potential for GHG emissions in the energy system and industrial emissions including other gases than CO_2.

The direct emissions and the potential for mitigation from agriculture were estimated using the land use change model of the integrated assessment model IMAGE of the Netherlands Environmental Assessment Agency (PBL, Planbureau voor de Leefomgeving).

IIASA's[5] G4M and GLOBIOM models were used to assess the potential for mitigation from both reduced deforestation and increased afforestation, mainly to foresee increased demand from bio-energy. Also indirect emissions from deforestation due to agriculture, including increasing demands for bio-energy, were assessed with this set of models.

[3] The 15th Conference of the Parties to the UNFCCC and the 5th Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

[4] COM(2005) 35 final, COM(2007) 2 final

[5] International Institute for Applied Systems Analysis (IIASA)

The GEM-E3 model of JRC/IPTS is a general equilibrium model that was employed to assess the macro-economic effects of various mitigation scenarios covering all economy-wide emissions except those from land-use change.

The TM5 model from JRC/IES was employed to estimate the effects of different GHG emission scenarios and their corresponding energy consumption on local air pollutants.

The GAINS Europe and GAINS Asia models from IIASA were used to assess the inter-linkages between GHG and local air pollution abatement policies and their respective costs if applied in parallel.

Finally JRC/IES provided a spreadsheet based tool to assess the impact of different accounting rules for the Land Use, Land Use Change and Forestry (LULUCF) sector for the current developed countries under the Kyoto Protocol based on historic data for the base year 1990 or the base period 1990-1999.

A more detailed description of the models can be found in Annex 1 of this Staff Working Document (Part 2).

1.2. Stakeholder Consultation

An internet consultation "Towards a comprehensive and ambitious post-2012 climate change agreement" was conducted from 4 August to 10 October 2008. It received 324 responses, out of which 59% were from individuals and 41% from organisations. From organisations most contributions were received from non-governmental organisations (37%) and organisations representing private sector (36%). Most active respondents were from Germany (21.5%), followed by Belgium (15.5%), France (12.9%) and the United Kingdom (12.6%).

Furthermore a stakeholder conference was held on 15 October 2008. Over 200 participants from public authorities, business community, trade unions, consumer organisations, academia and NGOs from developed and developing countries shared their views on the key elements of a global post-2012 climate regime[6]. The event in particular focused on mitigation commitments by developed countries, mitigation actions by developing countries and adaptation to climate change. Underneath a summary is presented on the main issues raised by stakeholders in the consultation and the conference. For specific elements regarding the issues raised in the stakeholder conference, see also Annex 2 of this Staff Working Document (Part 2).

Most stakeholders agreed that the goal of reducing global greenhouse gas emissions by at least 50% below 1990 levels by 2050 is needed to tackle the climate change challenge. In addition, it was often stated that to make this long-term target credible, there is a need for (1) interim emission reduction targets for 2020 and 2030 to ensure 2050 goal attainable; (2) a commitment by industrialized countries to reduce their own emissions by at least 80% below 1990 levels by 2050; (3) financial and other support by industrialized countries to developing countries to ensure that the transition to low carbon economy is compatible with development and poverty reduction goals.

Some stakeholders expressed concerns that current objectives are not ambitious enough as 450ppmv scenario provides only for 50% probability to stay below 2 degree target. Therefore,

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[6] For background information, see: http://ec.europa.eu/environment/climat/post_2012/reg.htm

it was suggested that the emission reduction goals should be revised over time in the light of the latest available scientific research.

A need for broad and comprehensive post-2012 climate change agreement was expressed, including fast developing countries like China and India.

Among other elements of shared vision, the need to tackle emissions from deforestation was commonly mentioned. Importance of energy efficiency and necessity for lifestyle changes was also emphasised.

Most stakeholder recognised that based on the historical responsibility, developed countries must take the lead by committing to binding absolute emission reduction targets reflecting comparable efforts. Need for redefinition of "developed countries" was pointed out by some stakeholders. Emission reductions made up to date (since 1990), capacity to pay for emission reductions (GDP per capita) and GHG emissions per capita were among the criteria most often mentioned for determining comparable efforts. Other criteria included emission intensity of the economy, technological potential to reduce emissions, historic responsibility and the UN's human development index.

Regarding developing country mitigation actions, most stakeholders considered that all countries should undertake sustainable policies and measures as a means of realizing low carbon development. Recognising wide differences among developing countries, many stakeholders considered that different types of mitigation actions are appropriate for different developing countries. However, many noted that all countries should stop subsidising fossil fuel extraction and use, and nuclear power, that could increase the cost of the energy sector.

Even though emission reduction actions would differ among developing countries, there should be a common monitoring, verification and reporting system. Technology and financial assistance for mitigation in developing countries should be measured, reported and verified according to actual and additional mitigation achieved (e.g. tons of $CO2$ equivalent avoided) as a result of assistance given by developed countries.

Carbon leakage is a concern for many stakeholders. Most commonly proposed measures to avoid relocation of industries were a comprehensive global agreement, sectoral approaches, free allocation in EU ETS for industries concerned and border adjustment measures.

Some stakeholders considered that a stronger cooperation between the UNFCCC and ICAO (International Civil Aviation Organisation) and IMO (International Maritime Organisation) would be is needed to effectively address emissions from international air and maritime transport. It was also mentioned that sectoral approaches could play a positive role in this context.

Since emissions from deforestation and forest degradation (REDD) account for some 20 % of global GHG emissions, necessary incentives to reduce these emissions should be found. Forest-based carbon credits and auction revenues were among most commonly mentioned financing sources to reduce emissions from REDD. However, some stakeholders expressed concerns that allowing forest-based carbon credits in the EU ETS will drastically reduce allowance prices.

Many stakeholders considered that there are solutions to non-permanence, leakage and liability issues in monitoring emission reductions from REDD. To address leakage, any

REDD regime must be nationally based. Countries should take on obligations to reduce emissions from deforestation and countries instead of private companies should be responsible for delivering those emission reductions. Since the national approach will not eliminate international leakage, it is important that participation in any REDD regime is as broad as possible.

It was considered crucial that funding for adaptation is predictable and sustainable. Auctioning of Assigned Amount Units (AAU) was most commonly mentioned as a key measure for generating finance on the scale necessary to support adaptation in developing countries. International funds like Adaptation Fund or Least Developed Countries Fund were mentioned appropriate vehicles for financing adaptation. Adaptation activities should be conducted in a transparent way, and should draw on knowledge and learning from similar programmes, while formulating locally appropriate programmes. Adaptation decisions should be made at the lowest possible level. Coordinating the work of other international organisations, overseeing establishment of regional adaptation centres and regional information systems on climate change risks in developing countries were mentioned as potential roles of UNFCCC in adaptation.

Stakeholders' views on necessity of support schemes for development, demonstration and deployment of certain technologies were divergent. Some argued for some kind of technology cooperation mechanism. However, first of all it would be necessary for developing countries to identify the most critical technologies for their low carbon development and to assess gaps in domestic capacities to be able to benefit from this technology cooperation mechanism. Few argued that governments should ensure that existing policy tools such as carbon markets, CDM, tax incentives, regulations, and efficiency standards are applied appropriately to contribute to development, demonstration and deployment of technologies, but no specific support schemes are needed. International standards (e.g. for energy efficiency) as a way to facilitate the diffusion of modern technologies were commonly mentioned.

Renewable energy technologies and carbon capture and storage were among most commonly mentioned technologies for which support schemes would be needed. Intellectual property rights, removal of existing barriers and capacity building were stated as important elements for strengthening enabling environment for the deployment of the existing clean technologies.

Auctioning Assigned Amount Units was among the most commonly mentioned means of organising additional public financing. Establishing a system of micro credits for measures to enhance energy-efficiency and deployment of less GHG intensive technologies seemed useful to some stakeholders. Adaptation, leveraging massive clean technology uptake and reducing emissions from tropical deforestation and forest degradation were among priority areas for financial support in developing countries. Legal certainty and improved governance were mentioned among important factors to mobilise private sector financing.

Most stakeholders considered that the first step to good compliance is a new globally accepted agreement, which includes also all countries that did not sign up to the Kyoto Protocol. Many stakeholders thought that non-compliance with reduction commitments should be subject to sanctioning mechanisms. Such mechanisms could include a financial penalty, exclusion from international climate finance vehicles and limited trade sanctions (border tax adjustments).

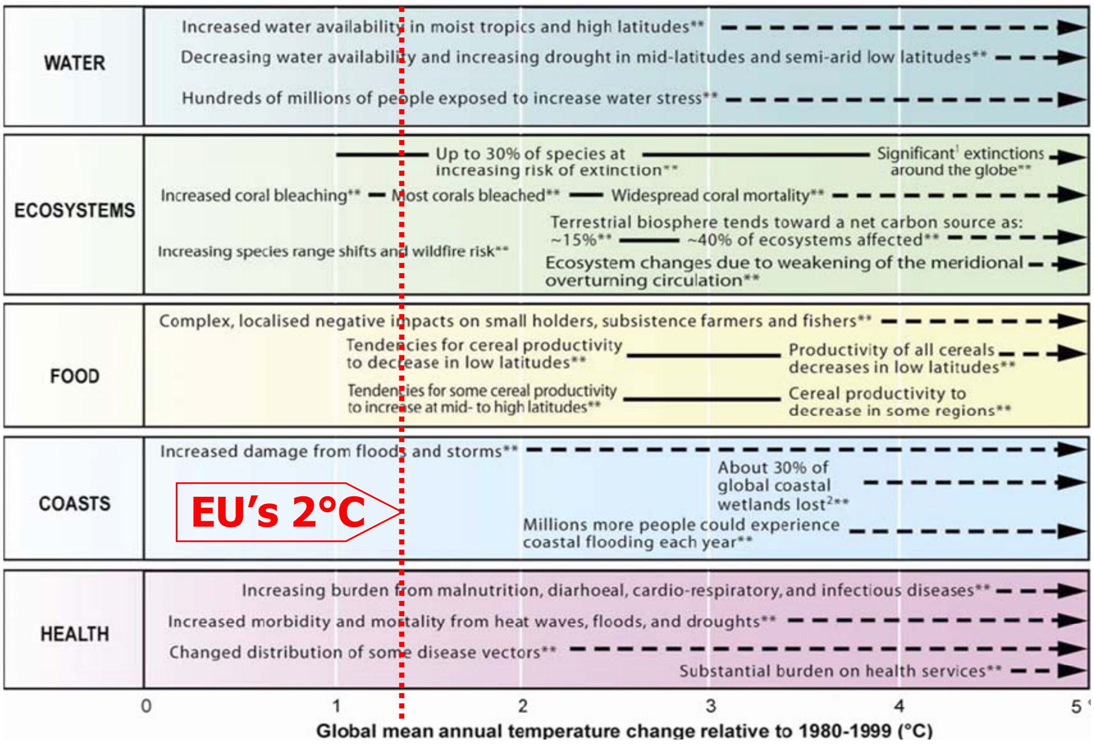
2. BACKGROUND

2.1. Global temperature increase needs to be limited

Climate change is happening and will have large and irreversible impacts if global temperatures continue to increase significantly. Already in 1996, the EU Council of Ministers put 2°C forward as the upper limit for this rise in temperatures compared to pre-industrial times[7]. This was based on the 2nd Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

The most recent IPCC 4th Assessment Report published in 2007 strengthens the scientific evidence of the need and the urgency to act against climate change given the wide variety of negative effects that will affect on a global scale our ecosystems that will in turn gravely affect our socio economic fabric. The figure below gives an overview of the type of impacts that can be expected when temperatures continue to increase.

Figure 1 Key impacts as a function of increasing global average temperature change



Source: Adapted from IPCC, 4th Assessment Report, Working Group II Report "Impacts, Adaptation and Vulnerability, Summary for Policymakers, Figure SPM2

Consistent with the findings of the IPCC, the EU Heads of State and Government reaffirmed the 2°C objective in their conclusions in March 2007[8].

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7 1939th Council Meeting, Luxembourg, 25 June 1996.

8 European Council, 8-9 March 2007.

Recent scientific publications that came out since the cut off date for the IPCC's 4th Assessment not only confirm the IPCC's earlier findings but are often even bleaker. For instance, research indicates the need to further increase global warming projections if geological and ecosystem feedbacks would be included in warming projections. One such feedback is the release of methane from decaying Arctic permafrost. New measurements of methane emissions from Siberian thaw lakes revealed that these emissions are already five times greater than previous estimates.

Also recent measurements of ice loss in the Arctic are worrisome. The observed sea ice decline is about three times faster than the mean model projections, which suggests that melting of Arctic sea ice is likely to happen much faster than projected by current climate models. Sensitive mechanisms have been identified with respect to Arctic summer ice and the Greenland ice sheet, where the thresholds for an abrupt change of the earth system was estimated in a range from 1°C to 2.5°C above pre-industrial level.

For more detailed information on the recent scientific findings, see Annex 3 of this Staff Working Document (Part 2) .

Similarly it is clear that even if temperature increase is limited to 2°C, there will be significant impacts from climate change. Some of these effects are already occurring. Therefore, there is not only a need to limit climate change to 2°C, but there will also be a need to adapt to inevitable changes. While developed countries can be expected to mobilise sufficient resources to adapt to these impacts domestically, developing countries, in particular the Least Developed Countries LDCs and most vulnerable countries, will be much less capable of doing so.

2.2. Urgent need for global action

The driver behind global climate change is the increase in anthropogenic greenhouse gas (GHG) emissions. The mean baseline projections[9] included in recent IPCC's 4th Assessment Report all see the 2°C limit surpassed within this century with a maximum of around 5°C and more for two baseline scenarios[10]. Recently recorded global emissions levels have tended to fall in line with the 'high emission' scenarios.

Historically developed countries were the largest source of GHG emissions, but in recent decades growth in emissions has been rising significantly in developing countries. The IPCC 4th Assessment Report estimated that developed countries accounted in 2004 for 46% of global GHG emissions, and developing countries for 54%[11]. This includes emissions from deforestation accounting for around 20% of global GHG emissions. Projections indicate that emission growth is expected predominantly in developing countries in the coming decades. The IPCC 4th Assessment Report projects emissions growth from energy up to 2030 to come

9 These are the potential future scenarios as defined in the IPCC Special Report on Emission Scenarios.

10 Based on the results presented in the IPCC, 4th Assessment Report, Working Group II Report "Impacts, Adaptation and Vulnerability, Summary for Policymakers, Figure SPM2 for the projected increase in temperatures for the A2 and A1FI scenarios. These scenarios were defined in the IPCC Special Report on Emission Scenarios

11 IPCC, 4th Assessment Report, Working Group III Report " Mitigation of Climate Change", Technical summary

for two thirds to three quarters from developing countries[12]. The IEA's World Energy Outlook 2008 projects that almost the entire increase in fossil fuel consumption in the baseline up to 2030 occurs in non-OECD countries. However, per capita emissions in developed countries continue to be significantly higher than even those of rapidly industrialising developing countries.

At the same time emissions would need to peak globally by 2020, and then would have to be reduced by up to 50% compared to 1990 in 2050, if a 50% chance to limit temperature increase to 2°C is to be achieved[13]. In order to arrive at a higher likelihood that temperatures will not surpass 2°C, global GHG reductions will need to be significantly more than 50% by 2050 compared to 1990.

It is obvious that such emission limitation and subsequent reductions on a global scale can only be achieved if there is global participation in the fight against climate change. The 2005 Communication[14] "Winning the Battle Against Global Climate Change" already highlighted the need for global action. It also pointed out that reducing deforestation will have to be part of the answer and that it is not possible to continue a situation where two of the fastest growing global sectors, i.e. aviation and maritime transport, are continued to be excluded from any type of action.

The 2007 Communication[15] "Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond" assessed the type and level of action that would be required. It concluded that developed countries should take the lead and commit as a group to a reduction target of -30% compared to 1990 by 2020. But the Communication also underlined that in developing countries the rate of growth of overall emissions will have to start to fall, followed by an overall absolute reduction from 2020 onwards.

The IPCC's 4th Assessment Report[16] indicated that in order to have a 50% chance to limit climate change to 2°C[17], developed countries as a group would have to commit to GHG emission reduction targets in the order of –25% to –40% below 1990 levels by 2020. The IPCC concluded that in addition to developed countries action, developing countries’ emissions need to substantially deviate from baseline in a number of key regions.

The authors of this part of the 4th Assessment Report have since then quantified the necessary range of this deviation[18]. They estimate that a deviation of 15% to 30% compared to business as usual emissions by 2020 is necessary for all sectors excluding deforestation. If emissions

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12 IPCC, 4th Assessment Report, Working Group III Report " Mitigation of Climate Change", Summary for Policy Makers

13 This is in line with emission scenarios where GHG concentrations first overshoot 450 ppmv and then reduce back to 450 ppmv over time. In 2006 concentration of the six GHG included in the Kyoto Protocol had reached already 433 ppmv CO2 equivalent.

14 COM(2005) 35 final

15 SEC(2005) 180

16 IPCC, 4th Assessment Report, Working Group III Report " Mitigation of Climate Change", Chapter 13 Policies, instruments, and co-operative arrangements, Box 13.7

17 Stabilising GHG concentrations in the atmosphere at 450 ppm CO2-eq would give around 50% chance of limiting global temperature rise to 2°C compared to pre-industrial times.

18 den Elzen Michel, Höhne Niklas, 2008

from deforestation were to be reduced below baseline the deviation from baseline for the other sectors could be lower[19].

The European Spring Council of 9 March 2007 confirmed the -30% target for developed countries as a group and also endorsed an EU objective of a 30% reduction in GHG emissions by 2020 as its contribution to a sufficiently ambitious global agreement on climate change. The Council of the European Union also noted in its conclusions[20] the need for a deviation from baseline in developing countries of 15 to 30 % below business as usual in order to be consistent with the global emission reduction goal to stay within the 2 °C objective.

Part of this effort by developing countries to deviate with 15 to 30% from the baseline needs to be achieved by reducing emissions from deforestation. Recently the Commission addressed the need to tackle these emissions in its Communication "Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss"[21]. It proposes that in the UNFCCC negotiations on the future climate regime the EU aims to halt global forest cover loss by 2030 at the latest and to reduce gross tropical deforestation by at least 50 % by 2020 compared to current levels, delivering major climate change and biodiversity benefits by 2020. The aim was endorsed by the EU Council of Ministers[22] and will be pursued within the UNFCCC negotiations.

2.3. The EU and Commission's role in the international negotiations

The EU is widely seen as one of the parties with a leadership role in the international negotiations. This is underpinned by ambitious domestic action, for instance by creating the largest emissions trading system (EU ETS) globally, and by putting in place a 20% unilateral reduction target by 2020 to be increased to 30% if the international agreement is sufficiently ambitious.

The EU speaks with one voice in international environmental negotiations, and the Community is a full signatory to the UNFCCC and its Kyoto Protocol. This requires internal coordination in the EU Council to establish a common EU position. EU Environment Ministers lead on the coordination, but relevant dimensions are also discussed by Energy, Development, Finance and Foreign Ministers. In recent years EU Heads of State and Government increasingly provide overall guidance on key elements of the EU position. This underlines the significance and political priority the EU attributes to global climate change policy.

The Communication aims at contributing to the further development and refinement in the EU’s position towards the negotiations at COP15/MOP5 in Copenhagen. In the light of the current stage of the negotiations and taking into account proposals that have been tabled by other Parties up to now, it will need to address all the building blocks included in the Bali Roadmap. One focus will be on developing a comprehensive strategy for providing financial support as requested by the European Council in June 2008.

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19 The 15 to 30% range assumes that emissions from deforestation remain at baseline, so the range for emission deviations from baseline for those sectors excluding deforestation reduces when deforestation emissions reduce below baseline.

20 2912nd Council Meeting, Brussels, 4 December 2008.

21 COM(2008) 645 final of 17 October 2008

22 2826th Council meeting, Luxembourg, 30 October 2007.

Box 1 gives an overview of the key elements that have been set out by the EU as building blocks of a global agreement in order to ensure that average global temperature increase does not surpass 2°C above pre-industrial levels:

Box 1: Building blocks for a Copenhagen agreement proposed by the EU

– Developed countries as a group should commit to GHG emission reductions of 30% compared to 1990 by 2020.

– The EU is willing to take on a 30% reduction target itself provided that other developed countries commit themselves to comparable emission reductions and that economically more advanced developing countries contribute adequately according to their responsibilities and respective capabilities.

– Developing countries need to commit to appropriate mitigation action that leads to a deviation of GHG emissions from business as usual by about 15 to 30 % by 2020.

– Part of this action will need to be supported by developed countries as appropriate by finance, technology and capacity building.

– As part of this, appropriate action by developing countries it is needed to halt global forest cover loss by 2030 at the latest and to reduce gross tropical deforestation by at least 50 % by 2020 compared to current levels.

– Adaptation action is needed in all countries. The new agreement needs to provide support for effective adaptation especially for the poorest and most vulnerable developing countries.

– A new global agreement needs to address emissions from international aviation and shipping sectors that show fast growing GHG emissions.

3. PROBLEM DEFINITION: REACHING AN AGREEMENT WITHIN THE MULTILATERAL CONTEXT OF THE UNFCCC, ENSURING THAT AVERAGE GLOBAL TEMPERATURE DOES NOT INCREASE BY MORE THAN 2°C

The global fight against climate change is coordinated within the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, with the participation of more than 190 countries, at the annual Conference of the Parties (COP) to the UNFCCC that since its 11th meeting in Montreal in 2005 also serves as the Meeting of the Parties to the Kyoto Protocol (COP/MOP).

Under the UNFCC all countries are expected to contribute to the protection of the climate system in accordance with their common but differentiated responsibilities and respective capabilities. On the basis of this principle, Parties agreed that the developed countries should take the lead in combating climate change and the adverse effects thereof.

The leadership role of developed countries was translated in 1997 in the Kyoto Protocol into quantitative emission limitation and reduction objectives (QELROs) for those developed listed in its Annex B. The reduction targets for developed countries in Annex B only apply for the period 2008-2012. In 2005, at the UN climate change conference in Montreal, negotiations started on new commitments for developed countries under the Kyoto Protocol for the period after 2012. As the US is not a Party to the Kyoto Protocol, it does not participate in these negotiations.

At the same time, it was recognised that the current framework under the Kyoto Protocol will not suffice to limit climate change to 2°C, even with further targets for developed countries, but that further action on both mitigation and adaptation is needed. At the Bali UN climate change conference in December 2007 Parties therefore agreed to launch a comprehensive negotiating process, referred to as the Bali Roadmap. This process is set to conclude in 2009 at the UN climate change conference in Copenhagen.

Following the decisions taken in Montreal and Bali, the UN climate change negotiations are now taking place under two tracks:

– The first track, started in Montreal, focuses on further emission reduction commitments by developed countries under the Kyoto Protocol (Ad-hoc Working Group on the Kyoto Protocol or AWG-KP). This includes discussions on the future use and design of the flexible mechanisms that can be used by developed countries for compliance with their targets, the accounting rules for Land Use, Land Use Change and Forestry (LULUCF) in developed countries, and the future coverage of emission reduction targets (i.e. sectors, sources and gases).

– The second track, started in Bali, focuses on further actions to strengthen the implementation of the UNFCCC. It is exploring building blocks for an agreement on further action that affect all countries, including the USA and the developing countries (Ad-hoc Working Group on Long-term Cooperative Action, AWG-LCA). These building blocks focus on:

  – a shared vision for long-term co-operative action to address climate change

  – mitigation commitments of developed countries

– nationally appropriate mitigation action by developing countries
– enhanced action on adaptation
– technology cooperation
– investment and financial flows

Since Bali, four negotiating sessions have taken place during the course of 2008 (Bangkok, Bonn, Accra and Poznan), where Parties presented their views on the different elements under negotiation. These four meetings have revealed significant differences between the Parties' expectations for the Copenhagen agreement. At the same time, this first year of negotiations has provided Parties with a comprehensive overview of ideas and proposals and allows for substantive negotiations during the remaining four sessions until Copenhagen.

Key problems that will need to be tackled to obtain the necessary consensus on the different building blocks of the Bali Roadmap at Copenhagen are elaborated in sections 3.1 to 3.8 below. They cover the following elements:

– Individual GHG emission reduction targets for developed countries

– LULUCF accounting rules

– Surplus of Assigned Amount Units and the impact on future targets

– Appropriate action to be undertaken by developing countries

– Further development of the global carbon market

– Reduction in emissions from deforestation and forest degradation in developing countries

– Addressing international maritime transport and aviation

– Assistance for appropriate own action by developing countries through finance and technology

Annex 5 of this Staff Working Document (Part 2) gives a more detailed overview of the views of key parties on these different issues including the role of the G8 and the Major Economies meeting.

3.1. GHG reduction targets for developed countries

By Copenhagen, an agreement needs to be reached on the GHG emission reduction targets for developed countries (including for the USA). The EU has proposed that developed countries as a group should commit to a 30% reduction of GHG emissions by 2020 compared to 1990.

The EU has, however, yet to define specific method for how this target should be distributed among different developed countries. Other developed countries seem reluctant to engage in the discussion on the level of reduction targets necessary to stay within the 2°C objective or are only willing to do so if they see clear re-engagement by the US and sufficient engagement from developing countries. As the US will start to re-engage in these negotiations, the comparability of efforts between developed countries will become a key element of the discussions. At the UN climate change negotiations in Poznan in December 2008, Parties already agreed that further developed country targets should be "informed by the consideration of, inter alia, the analysis of mitigation potential, effectiveness, efficiency, costs and benefits of current and future policies, measures and technologies at the disposal of [developed country] Parties, appropriate in different national circumstances".

In setting further reduction targets for developed countries, two important sets of accounting rules must be taken into account, in view of their large impact on the potential of developed countries to meet their reduction target. These are the accounting rules for the Land Use, Land-Use Change and Forestry sector (LULUCF, see chapter 3.2 for problem definition) and the accounting rules for any surplus of emission rights carried forward by developed countries from the period 2008-2012 into the next commitment periods (see chapter 3.3 for problem definition).

3.2. LULUCF accounting rules

The LULUCF sector covers all activities related to land use (e.g. forests, croplands, grasslands, wetlands) and can be responsible for emissions (for example when a forest is converted into an agricultural pasture) and removals of GHG emissions (for example when a long existing pasture is reforested).

For some countries, like the US and most EU Member States, the total balance of all GHG fluxes from the LULUCF sector results in a “net sink”, i.e. the sequestration rather than emission of greenhouse gases[23]. But the LULUCF sectors are not static and in some countries sometimes constitute a sink and sometimes a source. These variations can be very large and are linked to for instance large forest fires or insect pests which vary from one year to another[24].

Under the Kyoto Protocol countries need to take into account these LULUCF sectors when they report on compliance with their targets. When these sectors are a net source, emissions needs to be added to the total GHG emissions of a country, and when the sectors are a net sink, then the country can issue additional emission rights (“removal units” or RMUs) which can be used for compliance or be traded via the emission trading mechanism under the Kyoto Protocol.

The present rules that govern LULUCF in developed countries are inconsistent and provisional due to the lack of data at the time they were agreed. There is no mandatory reporting for all LULUCF sectors. For some it is obligatory (afforestation, reforestation and deforestation) while others are optional (revegetation, forest management, cropland management and grazing land management.). For different sectors there are different accounting rules. Forests activities are accounted for using the so-called 'gross-net' accounting method while for agricultural activities (cropland and grazing land management) the 'net-net' accounting approach was adopted[25]. In the case of forest management, 'national caps' were

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23 For example: In 2005, net removals from the LULUCF sector were estimated to amount to 315 MtCO2 for the EU 27 (8% of the EU GHG emissions) and 10 Mt CO2 in the USA (11% of USA’s GHG emissions).

24 For example: In 2004, the Canadian LULUCF sector resulted in a net source, estimated to 11% of Canada’s overall GHG emissions for the year 2004 whereas in 2005, the Canadian LULUCF sector was estimated to be a net sink (2% of Canada’s overall GHG emissions for the year 2005).

25 For more background information on these specific issues, including what the difference is between 'gross-net' and the 'net-net' accounting approach, see annex 8.10

agreed in the Marrakech accords, which were in part politically motivated and which are due for review before 2012. The cap for forest management often limits the incentives to look for and develop climate friendly practices, rewarding mainly business as usual. These rules were meant to undergo some revision after 2012. The following are the main problems that will need to be tackled in this sector in an international agreement:

– There is a clear need for better harmonising the approach to account for LULUCF across all developed countries, ensuring that no sector can be left out that poses a considerable risk of the release of the enormous quantities of GHG stored in soils and biomass into the atmosphere.

– In the current set of rules for the LULUCF sector, countries lack consistent incentives to develop climate-friendly policies in the LULUCF sector. Rules often do not encourage real additional action in the LULUCF sector to mitigate GHG emissions and increase GHG removals. The forest management cap is a good example where to a large extent business as usual behaviour is credited. A future international agreement should set real incentives for additional mitigation action.

– The accounting rules needs also to encourage national policies and actions that promote an effective contribution of agriculture and forestry to climate change mitigation, including through the reduction of emissions, the protection and enhancement of sinks and carbon stocks and the development of sustainable supply of bioenergy and wood material.

– The complexity of the natural processes, high uncertainties in the measurement, the difficulty in differentiating between anthropogenic and natural emissions, and high inter-annual fluctuations (part of them outside, or only limited, human control) need to be recognised in the accounting rules. This needs to be done in a conservative manner to ensure that real incentives are created for additional action from land managers..

3.3. Accounting rules for a surplus of Assigned Amount Units

Under the Kyoto Protocol, developed countries reduction targets get translated into a total absolute amount of allowed emissions over the entire commitment period (2008-2012), called a country's Assigned Amount. This Assigned Amount is issued into a country's registry in individual Assigned Amount Units (AAUs), each representing 1 ton of CO_2-equivalent emissions. These are the emission rights that can be transferred under the Kyoto Protocol's emission trading mechanism and these are also used, together with other units created under the Kyoto Protocol, to demonstrate compliance with a country's Kyoto Protocol target.

If countries have lower emissions than their target provides for, they have a surplus of AAUs, which they can transfer to other countries with a reduction target or bank into a next commitment period after 2012 to be used for compliance purposes. The present accounting rules under the Kyoto Protocol foresee that developed countries that reduce emissions below their target for the period 2008-2012, can bank any unused emission rights to the next commitment period for compliance purposes.

Some developed countries have at present large excess quantities of such emission rights because their emissions are well below their reduction targets as foreseen for the first commitment period.

The excess emission rights that can be transferred to the period after 2012 are much larger than expected at the time the Kyoto Protocol was agreed. When the Kyoto Protocol was agreed, the expectation was that the US would purchase a large part of this surplus. The US non-ratification of the Kyoto Protocol means that a large excess of emissions rights may be banked into a future commitment period. This would make it significantly easier for developed countries to achieve future reduction targets without taking additional mitigation action in the period after 2012, thereby potentially creating a problem in relationshiop to the environmental integrity of targets in a next commitment period.

3.4. Appropriate action by developing countries

The Bali Action Plan (paragraph 1,b ,ii) recognises that developing countries need to undertake nationally appropriate mitigation action. The EU has indicated that developing countries should undertake nationally appropriate mitigation action that leads to a deviation of GHG emissions with 15 to 30% from business as usual by 2020. Developing countries however oppose taking on quantified emission reduction commitments as envisaged for developed countries. Most importantly, the Bali Action Plan draws a clear link between the ability for developing countries to take nationally appropriate mitigation action and the need to support and enable that action by technology, financing and capacity-building.

In the context of the negotiations up to Copenhagen, the EU needs to specify in more detail, what action it is expecting from different developing countries, what instruments need to be included in the Copenhagen agreement that can ensure that developing country action is sufficiently ambitious and how developing country actions and support for it can be measured, reported and verified under the UNFCCC.. As The EU should explore options to support developing country action by technology, financing and capacity building and ensure that the carbon market will also support part of this action by developing countries through offsetting mechanisms that go beyond mere crediting compared to a baseline.

3.5. The development of a global carbon market

Large differences in the marginal abatement costs between regions and sectors and in the ability to pay or the responsibility to reduce emissions often imply that those countries or sectors that take on ambitious reduction targets do not always have the most cost efficient reduction options. These differences are a key driver for the creation of market-based mechanisms that allow for trade in emission rights between countries or sectors that have a cap and trade system in place or the trade in credits generated in countries or sectors that have no reduction obligation but can generate credits for reductions beyond a certain level which can then be used for compliance in countries/sectors that have a reduction obligation (i.e. so-called offsetting mechanisms)[26].

In theory, perfect trading mechanisms, including the link between cap and trade systems and offsetting mechanism, lead to equalisation of the marginal abatement costs which in turn ensures cost-efficient reductions. The benefits of such market mechanisms are twofold. Firstly, they guarantee the environmental outcome set by the cap. Secondly they allow for the

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[26] See annex 9.18.1 for a glossary of carbon market terms used in this staff working document .

differentiation of efforts in accordance with the ability to pay or other allocation criteria[27] while achieving a cost-efficient outcome.

This makes emissions trading a superior policy tool in an international framework compared to international carbon taxes, which in principle would also allow for the equalisation of marginal abatement costs and thus cost efficiency provided that such an international tax would be set at an equal level across all countries/sectors. Furthermore, an international tax does not guarantee ex ante a certain environmental outcome. Apart from these disadvantages, it is also politically inconceivable that a common level of international taxes would be accepted at a global scale that is sufficiently ambitious to stay within the 2ºC objective. This option will therefore not be further analysed.

Since the ratification of the Kyoto Protocol both the public carbon market (mainly through acquisitions of CDM credits by governments but lately also to some extent through trades in AAUs) and the private carbon market (through the creation of the EU ETS) have boomed. In 2007 global trade was estimated to reach US$ 64 billion of which trade in EU ETS allowances represented US$ 50 billion. But the current market is not perfect and marginal abatement costs have not equalised across the globe.

In the coming year it is to be expected that the carbon market will further develop. Individual countries or regions are setting up emissions trading systems for their domestic sectors, for instance in the US, Australia and New Zealand (see Annex 5 of this Staff Working Document (Part 2) for more information). These country-specific systems all have access to some degree to some type of offsetting mechanisms and are likely to be linked up over time, and by doing so increasing cost efficiency. This will create a better functioning carbon market in the coming decade, certainly between those regions that have set a reduction target and introduce cap and trade systems within their country.

The global carbon market is often put forward as the mechanism of choice to reduce global costs of mitigating GHG emissions and at the same time realise GHG reductions in developing countries through offsetting mechanisms. This can be problematic. While it is correct that the global carbon market reduces costs through access to offsetting mechanisms, there are problems with the continued use of offsetting mechanisms such as the Clean Development Mechanism (CDM) in its present form. These include problems of scale, where it is questionable whether the project-based format of the current CDM can deliver a sufficiently large amount of offsets, but also of quality, where questions have been raised on the environmental benefit of specific types of CDM projects. In addition to that, a continued use of purely offsetting mechanisms may increasingly undermine incentives for developing countries to implement actions that reduce their emissions without producing offsets. Therefore the international agreement will need to ensure that offsetting mechanisms evolve in such a way that they go beyond mere crediting and also stimulate appropriate own action in developing countries that does not generate credits. In addition to that, offsetting mechanisms should not lead to double counting. Any reductions that generate credits in developing countries that can be used to offset targets in developed countries cannot be counted towards the mitigation efforts by developing countries.

[27] Effort can be set differently by varying the cap per country/installation in a cap and trade system or by setting more or less ambitious levels that need to be met before crediting can happen in offsetting mechanisms.

3.6. Action to reduce emissions from deforestation and forest degradation

Part of the appropriate action by developing countries consist out of reducing GHG emissions from deforestation and forest degradation (REDD). These are often seen as a relatively cheap reductions option, with large co-benefits through decreased biodiversity loss, however with a large uncertainty in relation to the costs to achieve these reductions.

In practice there are large uncertainties on costs. If developing countries need to be compensated for decreasing their deforestation rates, costs can vary widely depending on the amount of leakage that occurs. Leakage happens when the activity causing deforestation in one project area is shifted to a different location outside the boundaries of the project area. If no leakage occurs, only the forest area targeted for avoided deforestation ("the frontier forests") needs to be included in the system, as such leading to relatively low costs per ton of CO2 emissions avoided. If leakage occurs, cost can however greatly increase, because of the need to compensate a larger area than the one that would have been deforested. Leakage on a global scale would translate into the need to compensate for the continued conservation of all standing carbon stocks globally. Therefore leakage is a key problem to be addressed in an international agreement.

Furthermore there is dual pressure on deforestation due to climate change mitigation policies. On one hand, climate change mitigation policies try to reduce emission from deforestation directly. On the other hand, without appropriate sustainability criteria and proper enforcement of the relevant national law, the increased demand for biofuels and biomass might increase pressure on land use and induce deforestation and the conversion of virgin forests into plantation. The international agreement will have to ensure that the right balance can be found between these opposing forces.

3.7. Addressing emissions from international maritime transport and aviation

Emissions form international aviation and maritime transport are one of the fastest growing sources of GHG emissions globally. Yet, those emissions are not controlled under the UNFCCC and its Kyoto Protocol. The Kyoto Protocol provides for Parties to work through the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO) to address emissions from these sectors. However, over the past decade, work performed within these organisations did not result in concrete actions to address appropriately the growth in emissions in these sectors which continues to threatens to significantly impair global emission reduction effort in other sectors

The EU has therefore called upon all Parties to agree clear and meaningful targets for these sectors within the framework of a future global climate agreement.[28] Stronger leadership by the UNFCCC and more concrete actions from ICAO and IMO are needed in this matter. There isalso disagreement among Parties on the respective future role of the different relevant organisations to regulate emissions from international aviation and maritime transport.

3.8. Assistance through finance and technology

The UNFCCC explicitly foresees that developed countries should enable developing country actions to mitigate GHG emissions and adapt to climate change through financial and

[28] Council of the European Union, Brussels, 19 October 2007

technological assistance. Emissions reduced in developing countries through such type of assistance can be counted for as appropriate action by developing countries because it does not lead to credits that can be used for compliance with reduction targets in developed countries.

The carbon market is likely to be the main source of finance for mitigation solutions in the longer run. It will, however, neither be sufficient in the short term and nor be the most appropriate means of support for all types of actions. As a consequence, new and additional sources of financing need to be identified to kick-start the transformation to a low-carbon economy for which assistance for developing countries will be necessary.

4. OBJECTIVES

4.1. General objectives

The general objective of the EU is to limit global average temperature increase to not more than 2 degrees Celsius above pre-industrial level.

4.2. Specific objectives

In support of the general objective, the EU wants to achieve an ambitious and comprehensive international agreement at the UN climate change conference in Copenhagen in December 2009. This international agreement will have to cover all the building blocks of the Bali Roadmap.

4.3. Operational Objectives

The international climate change negotiations in the coming year will focus on the level and type of required mitigation commitments and actions by developed and developing countries, and the necessary support to developing countries for both adaptation and mitigation, as well as the institutional architecture required to govern these actions and support

Building on the problem definition as set out in chapter 4 the operational objectives that are assessed through different policy options are the following:

a) Set fair, comparable and effective emission reduction targets for individual developed countries

To agree in the international agreement upon individual GHG reduction targets for developed countries in a fair, comparable and transparent manner that ensure that the group of developed countries takes on a reduction target equal to -30% by 2020 compared to 1990

b) Define LULUCF accounting rules that respect the environmental integrity of the agreement

To reach an international agreement that foresees new harmonised rules for accounting of LULUCF in developed countries that rewards real additional action in this sector.

c) Accounting rules for a surplus of Assigned Amount Units

Address the impact on the environmental integrity of the reduction targets for the period after 2012, when surplus amounts of assigned amount units could be banked under the international agreement.

d) Appropriate action by developing countries

Ensure that policy instruments are included in the international agreement that lead to measurable, reportable and verifiable mitigation actions under the UNFCCC, leading to a deviation of GHG emissions with 15 to 30% from business as usual by 2020.

e) Gradual development of a global carbon market

Improve the CDM and develop other international carbon crediting mechanisms that go beyond mere offsetting, as such strengthening the environmental integrity of the CDM and ensuring that the global carbon market not only reduces global mitigation costs but also stimulates mitigation action in developing countries that does not lead to the creation of offset credits.

f) Action to reduce emissions from deforestation and forest degradation

Ensure that policy instruments are included in the international agreement that would reduce gross tropical deforestation by at least 50 % by 2020 from current levels and halts global forest cover loss by 2030 at the latest.

g) Addressing emissions from international maritime transport and aviation

Ensure that policy instruments are included in the international agreement that would address the emissions from international maritime transport and aviation appropriately.

h) Assistance through finance and technology

Define adequate and predictable sources of assistance through finance and technology to support appropriate mitigation action and adaptation in developing countries.

5. POLICY OPTIONS

This staff working document will assess different policy options to ensure that the operational objectives can be met. This assessment is focused on the quantitative assessment of these policy options. Elements related to the further aspects of the institutional architecture are described in the annexes of this staff working document.

5.1. Distribution of a 30% reduction target for developed countries

In order to split the reduction target for developed countries in a fair and efficient manner, several criteria could be used, and some have already been proposed. Still, most developed countries have not yet expressed themselves what mid-term reduction target could be acceptable for them. The EU has proposed a 30% reduction target by 2020 compared to 1990 for the group of developed countries as a whole. The EU is willing to take up itself a reduction target of 30% if the future international agreement is sufficiently ambitious (see also Annex 8 of this Staff Working Document (Part 2) on the EU position on absolute reduction targets and the view of other developed countries on the issue of target setting).

Cost-efficiency

Cost efficiency is seen by a majority of countries as a key aspect when allocating targets. Reductions should take place where they are cheapest. However, when using cost efficiency as the sole rule for allocating efforts between different countries it raises serious issues as regards fairness.

For the EU's 20% unilateral target the Commission analysed in its impact assessment[29] a cost efficient policy case. This assessment demonstrated clearly that allocation of the effort to the EU Member States only on the basis of cost efficiency would lead to substantial differences in

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[29] SEC(2008) 85/3

the total economic costs that each of them would have to face. Because of the large number of low cost emission reduction options in Member States with lower GDP per capita they would incur relatively higher costs while having the least financial capacity to invest in GHG abatement. The Commission therefore concluded that these large national cost differences are not consistent with the need to share the effort in a fair and equitable way, which was agreed by the Spring European Council.

Within the group of developed countries, similar differences exist in economic development as can be found between EU Member States. A cost efficient approach is analysed in chapter 6.5.2 on the global carbon market. To determine the cost efficient allocation of the target in developed countries it's assumed that there is no emission trading at all with developing countries but that the carbon price does equalise within developed countries at a level that assures that the group of developed countries achieves the 30% reduction target internally.

As can be seen in **Table 12**, if targets would be set cost effectively (with no global carbon market), then the 30% reduction target leads to very high relative costs compared to GDP for those developed economies with a low GDP per capita but a high potential to reduce, e.g. for Russia. In Russia costs would be at around 2,5 times the global average.

Furthermore, a cost efficient allocation of the target does not give any information on the ability of countries to pay for emission reductions in developing countries through offsetting mechanisms.

For these reasons, the cost efficient approach will not be further analysed as an option to distribute the 30% reduction target among developed countries.

Allocation according to a set of simple indicators

The IPCC defines 4 main drivers for GHG emissions, i.e. changes in energy and carbon intensity, population growth, and global per capita income growth. While these are often seen as drivers for emission growth, they can also be looked at as indicators for the ability to mitigate.

1. GDP per capita

The income level of a country determines to a large extent the ability to pay for mitigation action. Rich countries have a higher ability to invest in reductions than poor ones and have a higher ability to invest in GHG reductions in other countries through offsetting mechanisms.

GDP/capita is selected as a first simple indicator that could be used to attribute a reduction target to a country. The higher the indicator, the more stringent the reduction target is set.

This indicator measures the ability to act today on climate change. As such there is no need to project GDP/capita but one can simply use recent available data. For this assessment data for the year 2005 was used.

One can measure GDP/capita in current prices or in purchasing power parity (PPP). As most clean environmental technologies and services required for large scale investments in a low carbon energy infrastructure are traded internationally at world market prices, the GDP/capita in current prices reflects more appropriately the ability to allocate the necessary financial resources.

2. GHG emissions per GDP

The amount of emissions a country needs in order to produce a certain amount of goods or services also indicates whether there is high or low potential to reduce emissions. Low carbon productivity can often be attributed to a carbon intensive energy mix or a high degree of energy inefficiency. This generally offers substantial mitigation potential at lower cost than those economies that have a low carbon energy mix or are highly energy efficient.

GHG emissions per unit of GDP is selected as a second simple indicator that could be used to attribute a reduction target to a country. The higher the indicator, the more ambitious the reduction target can be.

This criterion measures the ability to mitigate today. As such there is no need to project changes in GHG/GDP but one can simply use recent available data. For this assessment data for the year 2005 were used.

3. Population growth

Countries with an increasing population will have more difficulties to reduce their emissions than countries with stable or declining populations, assuming per capita income, carbon and energy intensity are all stable.

Population trend is, therefore, selected as a third simple indicator that could be used to attribute a reduction target to a country. The higher the indicator, the less stringent the reduction target can be.

The data used in this assessment are the historic population trends over the period 1990-2005.

4. Early action

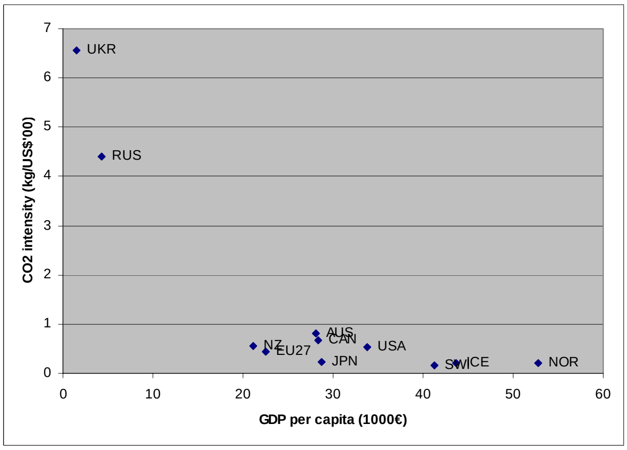
Since 1992, developed countries have the obligation under the UNFCCC to act on climate change. Over the period 1990 to 2005 total GHG emissions of the group of these countries has actually declined. But there have been huge differences in the country by country performance within this group with large reductions in some while others have increased their emissions substantially. By taking early action many emission reduction options have already been realised in the past. At the same time, taking early action into account provides a reward and an incentive for the future.

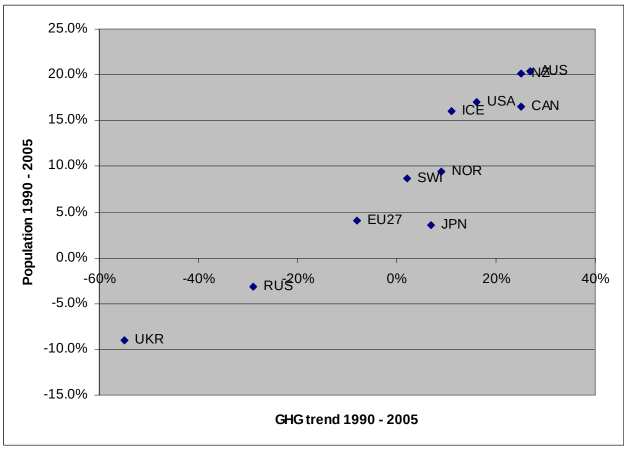
The observed GHG emission trend is selected as a fourth simple indicator that could be used to attribute a reduction target to a country. The steeper the reduction was since 1990, the less ambitious the future reduction target is set.

The data used in this assessment are the historic GHG emissions trend over the period 1990-2005, excluding the LULUCF sector.

The figure below gives an overview of the large diversity for the four indicators in the group of developed countries

Figure 2 Diversity in GHG intensity, per capita income, population and emission trends in developed countries





The options to distribute the -30% reduction target for developed countries that are assessed in chapter 6.2 are:

– Allocation on the basis of GDP per capita, addressing the capacity to pay for emission reduction within a country and through the global carbon market

– Allocation on the basis of GHG per GDP, addressing the opportunities to reduce GHG emissions within one economy

– Allocation on the basis of the change of GHG emissions between 1990 and 2005, rewarding early action by developed countries to reduce emissions

– Allocation on the basis of population trends over the period 1990 – 2005, recognising different population trends between countries and as such different pressures on the projected emission evolution

– Allocation on the basis of a combination of the criteria GDP/capita, GHG/GDP, GHG emission trends and Population trends.

5.2. LULUCF accounting rules on the 30% reduction target for developed countries

The options presented in chapter 5.1 and assessed in chapter 6.2 to distribute the 30% reduction target for developed countries do not take into account the land use, land use change and forestry sector (LULUCF sector) and thus might overestimate the cost impact if the LULUCF sector is a net sink for that country, or vice versa.

Using historical LULUCF data reported by countries through the UNFCCC reporting process, an assessment of the potential for different accounting options to reward business as usual actions and the potential impact on the environmental integrity of the reduction targets for developed countries was carried out.

The accounting options assessed are based on different proposals that have been tabled over the course of last year in the international negotiations. These are (see Annex 10 of this Staff Working Document (Part 2) for more detail on different options):

– **Option 0:** no changes to accounting rules and the forest management cap set at the same level as the one applied up to 2012. The optional sectors are accounted for in the same manner as countries have opted for at present.

– **Option 1:** option based on the current regime with no changes to accounting rules except an evolution by 2020 towards mandatory accounting for all activities, also for the Article 3.4 activities which are optional at present. For the forest management sector different discounts rates are applied instead of the present 'arbitrary' cap.

– **Option 2:** option based on the current regime but with net-net accounting for the forest management sector compared to a base period. There would also be an evolution towards mandatory accounting for all activities by 2020, also for the Article 3.4 activities which are optional at present.

– **Option 3:** option based on the current regime but the emission flux of the forest management sector would be compared to a forward looking baseline for forest management.

– **Option 4:** Full land based accounting as done at present under the UNFCCC inventories with net-net accounting.

These options are assessed in chapter 6.3

5.3. Accounting rules for a surplus of Assigned Amount Units

The operational objective is to ensure that the environmental integrity of the reduction targets for developed countries are not jeopardised when surplus amounts of Assigned Amount Units (AAU) are transferred (banked) into the post-2012 period of an international agreement.

The assessment establishes what the potential impact would be on the -30% target for the group of developed countries if surplus AAUs are allowed to be banked to the period after 2012 without special provisions.

As a sensitivity analysis, a second policy option is analysed. In this policy option the amount of surplus AAUs to be banked into the post-2012 period is reduced by the amount that might have been used before 2012 if the USA would have ratified the Kyoto Protocol. The result of this assessment gives a more informed view on what the expected amount of surplus AAUs was for the period after 2012, in 1997 when the Kyoto Protocol was agreed upon.

These 2 options are assessed in chapter 6.4.

5.4. Actions/technologies to achieve the reduction targets for developed countries and a substantial deviation from baseline in developing countries by 2020 and the development of the global carbon market to stimulate these actions

In the context of the negotiations up to Copenhagen, the EU needs to clarify in more detail, what level and what types of actions it is expecting from different developing countries and to what extent this action could be supported by different means, including through public and private funding or offsetting mechanisms that go beyond mere crediting.

On the level of ambition for this action the EU has proposed that developing countries should undertake appropriate mitigation actions to reduce the growth of their GHG emissions, resulting in a deviation of GHG emissions from business as usual trends of about 15 to 30% by 2020 whereas developed countries as a group should take on a reduction target of -30% compared to 1990 by 2020.

In order to evaluate the type of actions/technologies that would be required, a policy option needs to be assessed that simulates mitigation action on a global scale that achieves these levels of GHG limitations leading to a global peak in GHG emissions from energy and industry after 2015 and then a decrease from 2020 onwards. The following policy instruments are assumed to be in place to achieve this (similar to the policy assumptions in the 2007 impact assessment[30]):

1. A reduction of the global energy intensity is realised through energy efficiency policies such as setting standards. These are motivated by concerns about energy security and high energy prices. This includes specific measures to decrease the average energy consumption of new road vehicles. These measures have negative or low costs over the life time of the investment but they do have upfront costs which are included in the cost estimates[31].

2. Developed countries take on a collective emission reduction target in the range of 30% compared to 1990.

3. Developed countries set up a trading system such as the EU ETS or similar policy measures that establish a carbon price for the energy intensive industrial sectors, including the power sector.

4. Developing countries are not compensated (through instruments like the CDM) for all reductions they achieve in economical or low cost energy efficiency improvements or increase in vehicle fuel efficiency for vehicles because these

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[30] Impact assessment accompanying the Communication "Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond"

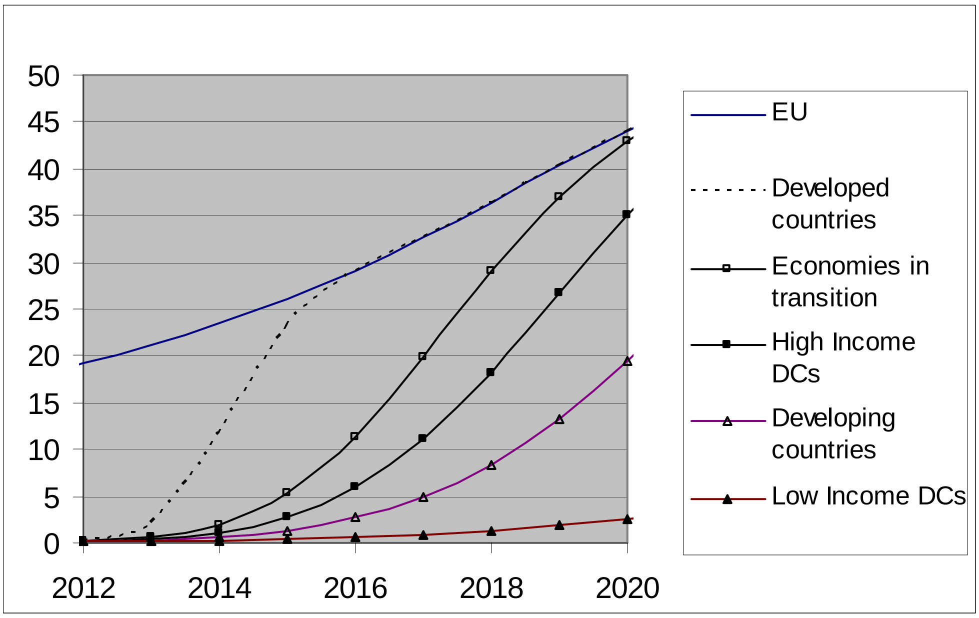
[31] Energy efficiency improvements that are not introduced through increases in the carbon price, related to the different energy transforming equipments and/or to the final energy use in the industrial, residential and services sectors, are modelled through autonomous energy efficiency indicators (AEEIs). For road transport the impact of measures, including standards, on the efficiency improvements of the whole transport fleet is modelled in the transport module of the POLES model, based by the assessment on their impact on fuel efficiencies of the newly introduced vehicles in the future. Estimates are made for the upfront costs of these energy efficiency improvements. These are based on studies by JRC for EU energy efficiency measures, a study by Resources for the Future on demand side energy efficiency policies, work for the 2007 US Energy Independence and Security Act and other energy efficiency related programs (e.g. Energy Star).

generate significant monetary co-benefits through reduced energy bills, increased energy security and improved air quality on the short and mid term.

5. A carbon market exists for the sectors included in the EU ETS but it is not perfect and thus not equalise Marginal Abatement Costs for the involved sectors on a global scale. Instead of this, the effective carbon prices are assumed to vary between the various regions in the world because of differences in transaction costs (see figure below), and they converge over time. Carbon prices are similar across markets in developed countries by 2015. Economies in transition follow suit but carbon prices would be equal as of 2020.

6. Energy intensive sectors in developing countries are exposed to a low carbon price in 2012, simulating the limited penetration or visibility of a carbon price for all individual firms through policy instruments such as the CDM. However, differences in the carbon prices become smaller over time as a result of a strengthened regulatory framework in close relationship with the state of development of the economy. Between 2025 and 2030, these differences in carbon prices become relatively smaller for all groups of countries apart from low income countries.

Figure 3 Carbon price developments over time in the global carbon market (€/ton CO_2)



Source: POLES, JRC, IPTS

7. Transport, residential and services sectors do not participate in the global carbon market. For these sectors, developed countries introduce in addition to energy efficiency improvements, policies that reduce emissions at a rate similar to the introduction of a carbon price. In developing countries, only energy efficiency policies in these sectors are implemented.

8. Emissions from aviation bunker fuels are included in the national/regional total emissions and thus costs estimates include also those for action in the aviation sector. On the contrary emissions from maritime bunker fuels are not included in the national totals.

This policy option is assessed in chapter 6.5.1

An important assumption to estimate the potential to mitigate GHG emissions and reduce costs is to what extent the global carbon market is further developed by 2020. In order to assess the potential of the carbon market to reduce costs 2 additional policy options will be assessed.

One where there is no global carbon market at all and one where there is a perfect global carbon market that equalises Marginal Abatement Costs on a global scale in the energy and industry sectors. These two extreme policy scenarios give the upper and lower bound of the cost estimates on a global scale.

These policy options are assessed in chapter 6.5.2 together with a analysis to what extent the results demonstrate that offsetting mechanisms, such as CDM, can also be used to give incentives for action that do not lead to crediting, as such given incentives for own appropriate action by developing countries.

5.5. Action to reduce emissions from deforestation and forest degradation

The EU has formulated a policy objective to halve emissions from gross deforestation by 2020. By 2030 net forest loss has to be reversed, reducing to zero the emissions from net deforestation[32].

It needs to be further assessed at what costs this objective can be met and what the impact will be on other land uses, most importantly agriculture.

Chapter 6.6 assesses the actions necessary in the forestry sector to reduce emission from deforestation and forest degradation (REDD) and associated costs but ensuring at the same time that any bio-energy demands due to increase climate change action are met. The same chapter also assesses if this is compatible with the need to apply also mitigation actions in the agricultural sector.

5.6. Actions to address emissions from international aviation and maritime transport

Due to the internationally mobile nature of emissions from these two sectors, it is preferable to address these emissions globally. Emissions growth for international aviation and shipping since 1990 has been high. Several policy instruments could be used to ensure that these sectors contribute to the global emission reduction effort.

Due to the limitations of the modelling framework, no separate quantitative modelling analysis was undertaken for policies that specifically address and single out bunker fuels (see below for further explanation). For the modelling exercise, aviation bunker fuels are included in the national/regional emissions in the analysis of chapters 6.5.1, 6.5.2.

Energy statistics for aviation bunker fuels are available. In the POLES model they are included in the transport sector. As such all analysis in chapter 6 includes aviation emissions

[32] Emissions from net deforestation are equal to the emissions from gross deforestation reduced with the net uptake of CO2 from afforestation and reforestation.

in national/regional emission data and thus also in the analysis of policies or impacts per country/regions.

For Maritime bunkers fuels, data is not readily available in a consistent way in the national energy statistics and the modelling could not be done in POLES on a national/regional scale. It should also be noted that there is currently no international agreement on the methodology to allocate international bunker fuels emissions to national/regional emission data, putting limitations on the modelling framework, most notably for maritime bunker fuels.

In the POLES model, reduction potential for both sectors is more limited than for other sectors. This confirms that absolute emission reductions compared to a base year are unrealistic for these sectors by 2020. But it is crucial that also they contribute to the reduction effort. They constitute one of the fastest growing sectors globally in terms of GHG emissions.

A qualitative discussion on the treatment of bunker fuels can be found in Annex 19 of this Staff Working Document (Part 2).

5.7. Sources of financing complementing the carbon market

As stated in the problem definition, further support by developed countries for developing countries action on mitigation and adaptation will be necessary. Several options are on the table as to how such new contributions could be generated, as listed below:

– Argentina has proposed that funding would come mainly from developed countries' governments who would contribute according to the UN scale.
– China and the G77 are calling for new national commitments from developed countries to spend 0.5% to 1% of their GDP on climate change - on top of existing ODA commitments.
– Mexico has proposed that all countries would be invited to contribute according to a formula based on principles such as: polluter pays (emissions); equity (per capita emissions); efficiency (emissions per unit of GDP); ability to pay (GDP per capita) population.
– Norway has proposed to auction a certain percentage of AAUs at international level. The revenues of this auction can be used to finance adaptation or other needs, such as technology development and deforestation in developing countries.

The Argentinean and the Chinese proposals push the responsibility towards the developed countries, the disadvantage is that the contributors would only include developed countries and therefore not involve, for instance, the emerging economies. The Norwegian proposal has the advantage that it uses the carbon market to ensure new finance. For financing of adaptation this seems acceptable as it would mean that the assistance for adaptation becomes the responsibility of the economies who have historical responsibility, however, when it comes to mitigation a better option would be to choose a mechanism that also makes future emitters responsible. In order to realistically reflect the principle of common but differentiated responsibilities and respective capabilities, one possible option would therefore be to work further on defining a distribution key on the basis of the Mexican proposal by using indicators that reflects the polluter pays principle (emissions); equity (per capita emissions); efficiency (emissions per unit of GDP); ability to pay (GDP per capita) and population.

Whether the setting up of new funds or structures is the best way forward or whether existing vehicles with existing experiences could be used for the same purposes needs to be further analysed as well as the potential sources to feed mitigation initiatives. Experience with the funding in the fight against AIDS already shows that a combination of multi-lateral and bi-lateral funding targeted towards solving specific issues seems to be the most effective route. In the case of adaptation and mitigation that even cover a all economic sectors an even more diversified approach might be necessary in order to reach those areas where funding is mostly needed.

The analysis in chapter 6.7 will specifically assess the following options to raise international public finance based on different scales of contribution:

– Official Development Assistance contributions

– UN scale

– Polluters pays principle, i.e. emitted GHG emissions, both applied only on developed countries or on a global scale

– GDP

Furthermore the analysis in chapter 6.7 will briefly touch upon the option to use the carbon market as a source of financing by using the revenue from auctioning.

6. ANALYSING THE IMPACTS OF THE DIFFERENT POLICY OPTIONS

6.1. Description of the baseline scenario and its assumptions

The main GHG emission baseline for this assessment is constructed using a number of models. This is necessary to ensure that all relevant GHG sources are covered. The following models are used:

– The POLES model for GHG emissions from the energy system and industrial processes;

– The land use change module of the integrated assessment model IMAGE for the emissions from agriculture;

– The forestry models G4M and GLOBIOM models for the emissions from deforestation, and uptake through afforestation and reforestation.

– The GEM-E3 model assesses the macroeconomic effects of the various policy scenarios.

Are climate change policies incorporated in the baseline?

Emissions from the energy system and industry estimated with POLES in the baseline do not take into account any particular climate change policies with the exception of a 5 €/tCO2 carbon price in developed countries in the same sectors that are included in the ETS in the EU. This aims to simulate the fact that also in developed countries that presently lack ambitious climate change policies, investment decisions are already influenced by the prospect of future mitigation policies.

For the EU, the carbon price in the baseline is put at a higher level given the existence of an ETS in the EU. The carbon price in the EU ETS starts at 20 €/tCO2 in 2010 and increases linearly to 24 €/tCO2 in 2030. This is similar to the approach that was used in the baseline scenario to assess the impact of the EU climate change and energy package. It should be noted, however, that the baseline for the EU used for this assessment does neither include the implementation of the unilateral GHG reduction target (-20% compared to 1990 by 2020) nor the renewables target (20% by 2020) as proposed in the EU energy and climate change package, both of which were still under discussion when this assessment was made. Therefore the baseline used in this analysis does not include the outcome of the approved policy changes under the adopted climate change and energy package

GDP growth and oil prices

Average yearly growth is projected to be equal to 2.4% for developed countries and 5.3% for developing countries over the period 2005-2020 resulting in a yearly average global growth of 3.9%. The baseline takes into account the current financial crisis. The growth projections were adapted when the deterioration of growth prospects became obvious in autumn 2008. Growth rates were reduced using most recent IMF economic forecasts for the main regions for the coming 2 years. Afterwards, it is assumed that growth will pick up again and return to the same yearly level as before the economic recession. See also Annex 7 of this Staff

Working Document (Part 2) for the difference between the growth projections in the baseline and earlier growth rates not taking into account the economic crisis of autumn 2008.

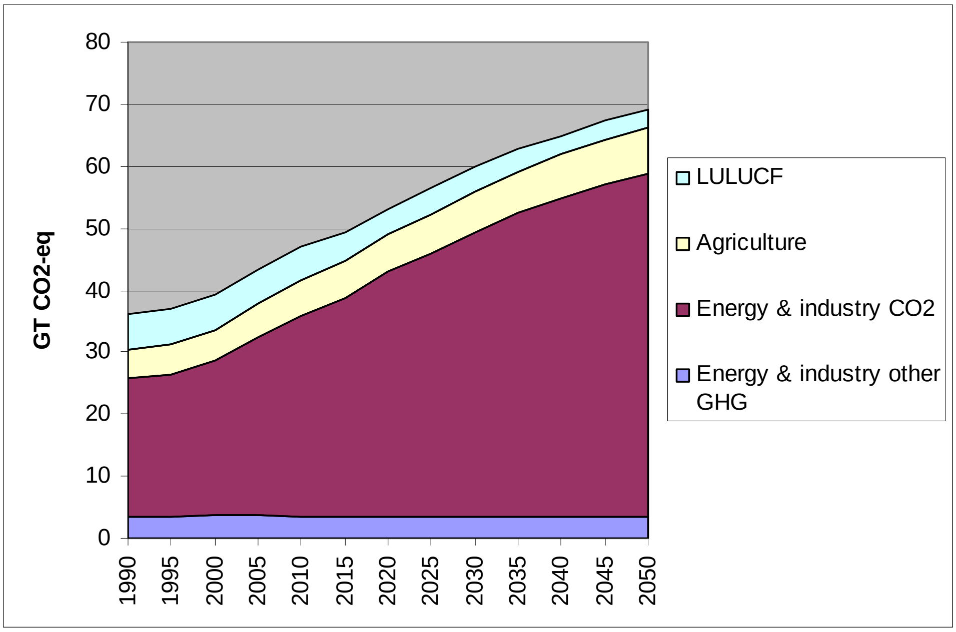
Oil prices in the updated baseline scenario differ from the ones in the 2007 Impact Assessment[33]. In the 2007 assessment, prices of 53.2 US$/bl in 2020 and 61.5 US$/bl in 2030 were assumed while for this assessment projected prices are expected to increase to 73 US$/bl in 2020 and to 91 US$/bl in 2030 (in 2005 prices). The proposed oil price scenario entails also higher coal and gas prices than those presented in the 2007 Impact Assessment. For comparison, these oil prices are lower than the most recent ones projected by the IEA in its World Energy Outlook 2008 that estimates price levels of 110 US$/bl in 2020 and 122 US$/bl in 2030 (in 2007 prices).

Total emissions in baseline

Despite the high oil price, total GHG emissions of energy and industry grow as fast in the new baseline than in the 2007 one. They increase by 69% above 1990 levels in 2020. This is mainly due to slightly higher economic growth forecasts for developing countries which have a high share of coal in their energy mix and also globally a slightly higher share of coal in the total primary energy mix.

Global emissions of energy, industry and agriculture, excluding LULUCF, increase by 63% over the period 1990-2020. They increased in the modelled baseline by 23% over the period 1990-2005 and are projected to increase by a further 33% over the period 2005-2020. The best estimate[34] of resulting global average temperature increase in the baseline in 2050 is projected to be already around 2°C above pre-industrial level and continues to further increase afterwards.

Figure 4 Baseline emissions all sectors



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33 Impact assessment accompanying the Communication "Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond"

34 The best estimate temperature projection was done using the MAGICC model, version 5.3

Source: POLES (JRC, IPTS), G4M (IIASA), Image (PBL)

Emissions in developing countries increase much faster than in developed countries.

In developed countries GHG emissions of energy, industry and agriculture, excluding LULUCF, decline over the period 1990 -2005 but increase again afterwards. By 2020 these result inbaseline emissions of around 1.5% below 1990 level.

Emissions of energy, industry and agriculture, excluding LULUCF, in developing countries increase significantly over the period 1990 to 2005 and are projected to increase at a slightly lower rate resulting in an increase of 166% over the entire period 1990-2020.

Annex 6 of this Staff Working Document (Part 2) gives further information how this baseline relates to baseline projections of other studies, e.g. those used by the IPCC assessment reports that are based on the scenarios described in the Special Report on Emissions Scenarios (SRES).

Energy emissions in the baseline

Emissions from energy use increase faster than emissions from other sources. On a global level they are projected to increase by 71% over the period 1990-2020. For comparison, the IEA baseline for the World Energy Outlook 2008 projected an increase of energy related global CO_2 emissions between 1990 and 2020 of 74%.

Energy GHG emissions are projected to increase by 6% and by 68% in 2020 compared to 2005 in developed countries and developing countries, respectively. Energy GHG emissions from developing countries overtake those of developed countries before 2010. By 2020 they are 43% above those of developed countries.

Baseline emissions from agriculture and deforestation

Emissions from agriculture are estimated by the IMAGE model. Global emissions from agriculture grow at a lower speed than those of energy and industry. They increase by 30% over the period 1990-2020. Agricultural emissions in developed countries decreased substantially over the period 1990 – 2005 and are projected to remain fairly stable over the period 2005 – 2020, while those in developing countries are reported to have grown by 23% over the period 1990 - 2005 and are projected to continue to grow by 51% over the period 1990 - 2020.

Finally, annual emissions from gross deforestation decrease in the baseline from a level of around 4.3 Gigaton CO_2 per annum in 2005 by around 20% by 2020 to around 3.5 Gigaton CO_2. This means that by 2020, the size of emissions from deforestation are about twice as high as the proposed EU ETS cap in the same year[35]. Almost all these emissions stem from deforestation in developing countries.

The baseline for the macro-economic assessment

[35] Proposal for a Directive amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community (2008/0013 (COD))

The GEM-E3 model complements the sectoral analyses in this staff working document . The GEM-E3 is a computable general equilibrium model that can assess the macroeconomic effects of the various scenarios. It models the interactions between all the sectors and agents in the economy taking as well the trade-related effects into account.

The GTAP 6 database has been used to calibrate the GEM-E3 model to its base year 2001. The baseline scenario to the year 2030 has been established by taking into account the GDP and CO_2 emissions of the POLES baseline scenario and also the agricultural Non-CO2 emissions which are not included in POLES. The resulting baseline is similar to the baseline based on the POLES + IMAGE models, even though the GEM-E3 baseline is slightly higher (see table below).

Note that the world version of the GEM E3 model provides less country level details. For the Commonwealth of Independent States (excluding Ukraine, Australia & New Zealand and the non-EU OECD countries in Europe aggregates have to be used.

Table 1 Baseline emissions, comparison POLES – GEM E3

Increase of emission levels compared to 1990 in 2020 in %		
2020	Developed countries vs 1990	Developing countries vs 1990
Baseline POLES + IMAGE (energy sector, industry and agriculture)	-2%	166%
Baseline GEM E3 model (energy sector, industry and agriculture)	2%	156%

Source: POLES, IMAGE, GEM-E3

6.2. Assessment of the economic impacts of various allocation options in reaching a 30% reduction target for developed countries

Comparability of efforts of developed countries is one major issue in the current negotiations. Therefore, the economic impacts of the various options for sharing the effort between developed countries were assessed with the help of the GEM-E3 model. All GEM-E3 emission reduction scenarios respect the following assumptions:

1. Developed countries take on a combined reduction commitment of 30% below 1990 levels by 2020.

2. Developed countries set up a cap and trade system for the sectors which are at present in the EU ETS, equalising the carbon price in these sectors among developed countries. Developed countries also have access to the global carbon market including carbon credits from developing countries. However, this global carbon market is not perfect but has significant transaction costs in transactions with developing countries.

3. Developing countries undertake nationally appropriate actions themselves both in the sectors typically in the ETS and the Non ETS.

4. In developing countries, policies are introduced allowing them to participate in the global carbon market.

– Firstly, it is assumed that the use of the offsetting mechanisms is limited to the sectors which are typically part of the EU ETS.

– Secondly, implementing project based mechanisms carries significant transaction costs. This means that the developing countries offer fewer reduction credits to the global carbon market than they would do without transaction costs. As a consequence, carbon prices in each of the developing countries remain below those in developed countries.

– Thirdly, the richer a developing country is the more advanced its policies/mechanisms are, and the lower the transaction costs. Hence, its carbon price gets closer to the one in the ETS markets of developed countries.

On the basis of recent UNFCCC emission data for the year 2005, developed countries need to reduce their emissions as group by about 27% between 2005 and 2020 in order to meet the EU's proposed 30% reduction target compared to 1990. In the following analysis the necessary effort is shared among developed countries according to the four options indentified in chapter 5.1. **Table 2** gives an overview of these options for the main developed countries.

Table 2 Key indicators of the four options for allocating the mitigation efforts among developed countries

	GDP per capita in 1000€, 2005	GHG/GDP, 2005, in kg of CO2 per US$(2000)	GHG trend 1990 to 2005 %	Population trend 1990 to 2005 %
EU27	22.5	0.43	-8	+4.0
Australia	28.1	0.80	+27	+20.4
Canada	28.3	0.67	+25	+16.5
Iceland	43.7	0.21	+11	+16.1
Japan	28.7	0.24	+7	+3.5
New Zealand	21.2	0.56	+25	+20.1
Norway	52.8	0.20	+9	+9.4
Russia	4.3	4.41	-29	-3.1
Switzerland	41.3	0.17	+2	+8.6
Ukraine	1.5	6.56	-55	-9.0
USA	33.8	0.53	+16	+17.1
[a] Adapted from World Bank and Eurostat				
[b] Data from IEA2007				
[c] Data database UNFCCC website				
[d] UN population data				

Using each of the four indicators targets were defined as shown in Table 3. In total, the individual country targets of all options add up to reach the overall -30% emission reduction target in 2020 compared to 1990.

Table 3 Example of targets for developed countries resulting from the four allocation options

	GDP/cap criterion		GHG/GDP criterion		Early action criterion		Population trends criterion	
	GDP per capita in 1000€, 2005	2020 Target compared to 2005	GHG/GDP, 2005, in kg of CO2 per US$(2000)	2020 Target compared to 2005	GHG trend 1990 to 2005 in %	2020 Target compared to 2005	Population trend 1990 to 2005 in %	2020 Target compared to 2005
EU	22.5	-25.1%	0.43	-20.1%	-8%	-22.4%	4.0%	-38.1%
USA	33.8	-45.3%	0.53	-26.8%	16%	-41.5%	17.1%	-13.1%
Japan	28.7	-37.1%	0.24	-6.1%	7%	-36.1%	3.5%	-38.4%
Canada	28.3	-36.5%	0.67	-32.5%	25%	-46.8%	16.5%	-14.4%
Australia, New Zealand	26.9	-34.2%	0.77	-36.7%	27%	-47.9%	20.3%	-6.2%
Other OECD Europe	45.7	-64.5%	0.19	-2.1%	5%	-35.1%	9.1%	-30.5%
Commonwealth of Independent States	3.6	15.5%	4.66	-46.0%	-35%	6.0%	-4.6%	-42.7%
Average Developed countries		-27.3%		-27.3%		-27.3%		-27.4%

Source: JRC, IPTS, GEM-E3

Table 4 below summarises the estimated economic impacts resulting from the different targets.

The allocation option that leads to the least economic impact for the group of developed countries is the one that uses GHG intensity of the economy, but this is also the one that has the highest negative impact on the Commonwealth of Independent States reflecting the very high mitigation potential but relative low GDP.

If one looks at the impact on welfare[36], US, Canada and Australia & New Zealand all would favour population trend as the preferred option to allocate targets, whereas the EU, Japan and Other OECD Europe would prefer the option based on the GHG intensity of the economy. Welfare in the Commonwealth of Independent States could even increase if targets were set only in accordance with the option using early action or GDP/capita. Europe would be faced with the highest economic impacts with the option using population trends as the sole indicator. USA, Japan and Other OECD Europe would incur highest welfare losses when using GDP/capita.

Relative impacts on GDP are very similar to the relative impact on overall welfare. Note that GDP decreases in the Commonwealth of Independent States, even when early action or GDP/capita is used as the indicator to establish the targets while economic welfare increases. The reason is that the Commonwealth of Independent States becomes a net seller in the carbon market, and uses the revenue rather for extra consumption than for investments that

36 Note that in the GEM-E3 model the consumers optimise their welfare (which is a function of Private consumption and leisure), whereas firms maximize their profits. GDP as such is not optimised; it results from the interaction between firms, consumers, the public sector, and the external sector.

would increase GDP growth. For employment and private consumption similar relative differences can be noted.

Another observation is that some of the policy options result in large differences in targets across developed countries resulting in very large differences in the economic impact. Most notably, the indicators for GHG intensity in the economy or population trends lead to very ambitious targets for the Commonwealth of Independent States, and their respective impacts become unacceptably high. Similarly, GDP per capita leads to very high impacts for Other OECD Europe. The same is true but to a lesser extent for Canada using the early action indicator.

Table 4 Results for 4 indicators and the example of related targets for developed countries

Change in 2020 compared to baseline				
Impact on economic welfare if targets are based on:				
	GDP/Cap	GHG/GDP	Early action	Population trends
EU27	-1.6%	-1.1%	-1.3%	-2.6%
USA	-1.2%	-0.5%	-1.0%	-0.3%
Japan	-1.0%	-0.1%	-0.9%	-0.9%
Canada	-2.2%	-1.6%	-3.1%	-0.8%
Australia & New Zealand	-1.8%	-1.7%	-2.6%	-0.7%
Other OECD Europe	-5.7%	-0.5%	-1.9%	-1.5%
Commonwealth of Independent States	1.2%	-8.5%	0.8%	-7.7%
Average Developed countries	-1.3%	-0.9%	-1.1%	-1.4%
Impact on GDP if targets are based on:				
	GDP/Cap	GHG/GDP	Early action	Population trends
EU27	-1.5%	-1.0%	-1.3%	-2.1%
USA	-1.2%	-0.5%	-1.0%	-0.5%
Japan	-1.0%	-0.2%	-0.9%	-0.9%
Canada	-2.0%	-1.5%	-2.7%	-0.9%
Australia & New Zealand	-2.0%	-1.8%	-2.8%	-1.0%
Other OECD Europe	-4.8%	-0.3%	-1.3%	-1.0%
Commonwealth of Independent States	-2.6%	-7.3%	-2.5%	-6.6%
Average Developed countries	-1.4%	-0.8%	-1.2%	-1.2%
Impact on employment if targets are based on:				
	GDP/Cap	GHG/GDP	Early action	Population trends
EU27	-0.4%	-0.4%	-0.4%	-0.7%
USA	-0.5%	-0.3%	-0.4%	-0.2%
Japan	-0.4%	-0.1%	-0.4%	-0.4%
Canada	-0.7%	-0.6%	-0.9%	-0.4%
Australia & New Zealand	-0.7%	-0.8%	-1.1%	-0.4%
Other OECD Europe	-1.8%	0.1%	-0.2%	-0.2%

Commonwealth of Independent States	-1.6%	-2.2%	-1.5%	-1.9%
Average Developed countries	-0.7%	-0.7%	-0.7%	-0.8%
Impact on private consumption if targets are based on:				
	GDP/Cap	GHG/GDP	Early action	Population trends
EU27	-2.1%	-1.4%	-1.8%	-3.3%
USA	-1.9%	-0.8%	-1.6%	-0.6%
Japan	-1.6%	-0.3%	-1.5%	-1.5%
Canada	-3.4%	-2.5%	-4.7%	-1.3%
Australia & New Zealand	-3.0%	-2.8%	-4.3%	-1.3%
Other OECD Europe	-8.3%	-0.6%	-2.5%	-2.1%
Commonwealth of Independent States	-0.2%	-12.5%	-0.7%	-11.2%
Average Developed countries	-2.1%	-1.2%	-1.8%	-1.8%

Source: JRC, IPTS, GEM-E3

Conclusion

Using an allocation option based on a single indicator leads often to disproportional costs or gains for single countries. Most notable, using GDP per capita as the sole criterion can lead to very high impacts in countries with exceptionally high incomes. The same is true for using GHG intensity of the economy or population trends for those economies that have a high GHG intensity or a decreasing population trend, respectively, while their GDP per capita is small within the group of developed countries. Therefore, it is unlikely that an allocation option based on a single criterion will gain political consensus.

Using a combination of criteria in order to define a target instead of a single indicator seems to have a much higher likelihood of being accepted by all developed countries. Alternatively, it might be necessary to cap the extreme values of certain indicators in order to ensure a fair allocation of economic efforts.

Table 5 illustrates one allocation option which is a composite of four indicators in order to define the target per country. In this illustrative case, the target is set as follows:

– For the indicator GDP per capita the country with the highest level (i.e. Norway) is attributed a -20% target by 2020 compared to 2005. The country with the lowest level (i.e. Ukraine) gets a target equal to 0%. A country that is around the average gets around -11.5% attributed for this indicator.

– For the indicator GHG intensity of GDP the country with the highest level gets a target of -20% by 2020 compared to 2005 while the country with the lowest level (i.e. Switzerland) gets -4%. A country that is around the average gets around -11.5% attributed for this indicator. The maximum level of the indicator is -20 % in order to avoid allocation of extremely high targets to Russia and Ukraine.

– For the indicator early action, the country with the lowest level of early action (i.e. Australia) gets a target of -20% by 2020 compared to 2005. The country with the highest level of early action is allowed to increase its emissions by 8%. A country that is around the average early action gets around -8.5% attributed for this indicator.

The minimum level of the indicator is capped, to avoid allocation of extraordinary high targets to Russia and Ukraine. Both Russia and Ukraine get a +8% attributed for this indicator

– For the indicator population trend, the country with the highest decreasing population trend (i.e. Ukraine) gets a target of 0% by 2020 compared to 2005. The country with the fastest increasing population (i.e. Australia) is allowed to increase its emissions by 10%. A country that is around the average population trend gets around 2% attributed for this indicator.

The total target by 2020 compared to 2005 is simply the sum of the 4 targets attributed for each of the indicators (for further details see Annex 9 of this Staff Working Document (Part 2)).

Table 5: Example of a distribution of targets for developed countries, example in GEM E3 using 4 indicators

	Share according to GDP/cap	Share according to GHG/GDP	Share according to GHG '90-'05	Share according to Population '90-'05	Target relative to 2005
	(a)	(b)	(c)	(d)	(e) = (a+b+c+d)
EU27	-10.2%	-10.1%	-5.2%	1.7%	-24%
USA	-14.3%	-12.3%	-15.9%	8.2%	-34%
Japan	-12.8%	-5.6%	-12.5%	1.7%	-29%
Canada	-12.6%	-14.6%	-19.3%	7.8%	-39%
Australia & New Zealand	-12.2%	-16.3%	-19.9%	10.0%	-38%
Other OECD Europe	-17.9%	-4.4%	-11.9%	3.7%	-30%
Commonwealth of Independent States	-1.0%	-20.0%	8.0%	0.6%	-12%
Average developed countries	-10.5%	-12.8%	-8.5%	4.5%	-27%

Table 6 below reports on the impacts projected for each region of the composite allocation option. The most important conclusions from this exercise are:

– For every country, impacts are between the extremes of impacts of the policy options based on single indicators (see Table 4).

– Overall impacts for the group of developed countries are very close to the outcome when GHG intensity would have been used as an indicator. From a cost perspective, a composite target seems to lead to an acceptable outcome.

– Impacts on welfare are highest for Canada and Australia & New Zealand who have also the highest targets compared to 2005. But also for the Commonwealth of Independent States it has a relatively high impact, certainly on GDP, even with relatively low targets compared to the rest of the group. The Commonwealth of Independent States still has a relatively low GDP, so even low absolute costs have relatively higher impacts than in the richer countries. It is important to note that for these countries where the economic impact looks relatively high compared to baseline in 2020, growth rates are also higher and thus impacts appear less significant when compared in terms of overall GDP growth over the period 2001-2020 (see Table 7).

– The US and Japan face the lowest economic impacts. For Japan this is partly due to the fact that it has a very low GHG intensity per GDP. So even if marginal costs are relatively high per ton of CO2 reduced, total costs are small compared to GDP. The US has a similar GHG/GDP intensity as EU-27 in 2020. Moreover the domestic production and exports of energy intensive products is higher in the EU-27 than in the US.

– Concerning Canada, Australia & New Zealand, these countries face higher impacts because their GHG emissions/GDP and energy consumption/GDP shares are rather high compared to the rest of developed countries. Furthermore, domestic production and exports of energy intensive industrial products are higher in Canada, Australia & New Zealand leading to higher macro-economic costs.

Table 6: Impacts resulting from targets based on a combination of indicators

Change compared to baseline	Target vs 2005	Economic Welfare	GDP	Employment	Private Consumption
EU27	-24%	-1.4%	-1.2%	-0.4%	-1.8%
USA	-34%	-0.7%	-0.8%	-0.4%	-1.2%
Japan	-29%	-0.6%	-0.6%	-0.3%	-1.0%
Canada	-39%	-2.2%	-2.0%	-0.7%	-3.4%
Australia & New Zealand	-38%	-1.9%	-2.0%	-0.8%	-3.2%
Other OECD Europe	-30%	-1.5%	-1.0%	-0.1%	-2.0%
Commonwealth of Independent States	-12%	-1.4%	-3.0%	-1.5%	-3.4%
Average Developed Countries	-27%	-1.0%	-1.0%	-0.6%	-1.5%

Source: JRC, IPTS, GEM-E3

Table 7: Impact on growth over the period 2001-2020

Growth in GDP over period 2001-2020		
	In Baseline	In Target case
EU27	38.9%	37.2%
USA	51.8%	50.6%
Japan	37.5%	36.6%
Canada	55.1%	52.0%
Australia & New Zealand	61.8%	58.5%
Other OECD Europe	38.1%	36.7%
Commonwealth of Independent States	99.7%	93.7%

Source: JRC, IPTS, GEM-E3

6.3. Impact of different options for LULUCF accounting rules on the 30% reduction target of developed countries

A quantitative analysis of the impact of the different options was carried out by JRC. It was assessed how large a sink or source the LULUCF sector would be if reporting data for the years 2001-2005 would be used as proxies for future emissions in the LULUCF sectors over a five year commitment period.

This assessment was made on the basis of the publicly available LULUCF data submitted by Parties under the UNFCCC or the Kyoto Protocol by 2008. These submissions contain only historical information (from 1990 to 2006) and the level of completeness of the information available differs from country to country and for specific LULUCF activities, which had to be complemented with further assumptions.

All 4 options were assessed as presented in 5.2 with the exception of option 3. Analysing the impact of option 3 would require the elaboration of provisions on how a Party is to establish a forward-looking baseline for forest management to assess emissions and removals, how anthropogenic emissions and removals from forest management during the subsequent commitment period will be assessed against the baseline, and how the baseline will be revised in response to natural disturbances. Given that few modelled projections on forest management are available at moment (to be used as hypothetical baselines), and given that very different approaches could be elaborated (i) to assess anthropogenic emissions and removals against the baseline, and (ii) to revise the baseline in response to natural disturbances, JRC concluded that at present an assessment of option 3 is not possible. Therefore finally only options 1, 2 and 4 were assessed (see table below).

Table 8 Accounting options assessed

Option	Art. 3.3	Art. 3.4
0 (KP rules)	Mandatory, gross-net	Voluntary. FM gross-net with fixed CAP. Other 3.4: net-net
1	Mandatory, gross-net	FM gross-net with discount factor. Other 3.4: net-net
2	Mandatory, gross-net	FM net-net with no discount factor. Other 3.4: net-net
4	Convention reporting (FL, CL, GL, WL, S, OL), net-net	

KP activities: Art 3.3: afforestation/reforestation (AR) and deforestation (D).
Art. 3.4: forest management (FM), cropland management (CM), grassland management (GM), revegetation (RV).
Convention categories: Forest land (FL), Cropland (CL), Grassland (GL), Wetlands (WL), Settlements (S), Other land (OL)

Source: JRC/IES

Table 9 shows the impact of different options of future accounting rules of LULUCF on the amount of emissions or absorptions accounted for, compared to the 1990 as a base year (excluding LULUCF). Negative values represent a carbon uptake while positive values represent a release of carbon into the atmosphere.

For options that use the net-net accounting methodology two different base periods are assessed, i.e. the year 1990 only and the period 1990 to 1999. In option 1 forest management is accounted for using the gross-net accounting method but different discount factors are applied, i.e. 100% (not accounting for forest management at all), 85% and 0% (no discounting of forest management). In all options the so called optional article 3.4 activities become mandatory to account for. Furthermore the forest management cap for the US is set to zero given that they are not a Party under the Kyoto Protocol and that therefore a cap for forest management was never defined for the US.

In analysing the results put forward in Table 9 it is important to keep in mind that the data set supporting this assessment is historical. Hence, this analysis does not allow assessing the effect of planned policies in the LULUCF sector. Further studies have been launched on projections for the LULUCF sector until 2020 but results will not be available soon enough to be taken into account in this assessment.

Table 9 Impact of different LULUCF accounting options on developed countries' targets

Net emissions: % compared to 1990 GHG without LULUCF (accounting period: 2001-2005)											
when relevant, net -net activities with→		1990 base year					1990-1999 base period				
Options →	**0** (KP rules)[1]	**1**[2,3]			**2**[2]	**4**	**1**[2,3]			**2**[2]	**4**
Discount for FM(%)		*100*	*85*	*0*			*100*	*85*	*0*		
Austria	-0,8	-0,5	-3,7	-22,1	-7,5	-5,3	-0,6	-3,8	-22,2	-2,7	-0,8
Belgium	0,0	0,0	-0,4	-2,4	-0,2	-0,2	0,0	-0,3	-2,3	-0,2	-0,2
Bulgaria	0,0	6,5	5,5	0,0	5,0	5,2	1,0	0,0	-5,5	0,3	0,3
Czech Republic	-0,6	-0,3	-0,8	-3,6	-1,1	-1,4	-0,1	-0,6	-3,3	0,7	0,6
Denmark	-2,1	-1,9	-2,5	-6,4	-2,3	-2,6	0,2	-0,5	-4,3	0,1	0,0
Estonia	0,0	0,0	-0,7	-4,6	8,0	8,2	0,0	-0,7	-4,6	4,6	4,7
Finland	-0,8	7,1	0,1	-39,9	-7,5	-11,7	6,6	-0,5	-40,5	-2,0	-6,0
France	-0,7	-0,5	-2,2	-11,5	-2,6	-4,0	-0,4	-2,0	-11,3	-1,9	-2,7
Germany	-0,6	-0,5	-1,4	-6,5	-0,5	-0,6	-0,4	-1,3	-6,4	-0,4	-0,4
Greece	-0,7	-0,3	-0,9	-3,9	-2,1	-2,1	-0,4	-0,9	-4,0	-1,7	-1,6
Hungary	-1,1	0,9	0,4	-2,5	0,9	0,8	0,7	0,2	-2,7	1,6	1,8
Ireland	-0,2	-0,1	-0,3	-1,2	0,7	-0,7	0,1	-0,1	-1,0	0,1	-0,7
Italy	-4,8	-3,7	-5,9	-18,4	-9,5	-6,9	-3,9	-6,1	-18,7	-6,3	-3,5
Latvia	-8,7	-4,4	-11,7	-53,0	18,4	23,9	-4,4	-11,7	-53,0	11,0	16,6
Lithuania	-4,4	-2,3	-4,5	-17,0	1,8	4,6	-2,3	-4,5	-17,0	-0,4	1,9
Luxembourg	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Netherlands	0,1	0,1	0,0	-0,9	0,2	0,0	0,1	0,0	-0,9	0,2	0,0
Poland	-0,9	-0,6	-1,7	-8,0	-1,6	-1,7	-0,5	-1,6	-8,0	-1,6	-1,5
Portugal	-1,3	0,9	0,1	-4,5	-5,6	-6,7	0,9	0,1	-4,5	2,2	1,3
Romania	-1,6	0,0	-2,2	-14,5	-0,5	-0,5	0,0	-2,2	-14,5	0,6	0,6
Slovakia	-0,2	-5,6	-6,4	-11,1	-5,0	-2,3	-4,3	-5,1	-9,8	-3,7	-1,8
Slovenia	-6,5	0,0	-4,0	-26,7	-11,0	-12,1	0,0	-4,0	-26,7	-5,2	-5,7
Spain	-2,8	-2,0	-3,4	-11,3	-2,0	-2,0	-2,0	-3,4	-11,3	-2,0	-1,5
Sweden	-4,0	-1,8	-5,2	-24,7	-14,0	-18,7	-2,2	-5,6	-25,1	8,0	4,6
UK	-0,3	-0,1	-0,4	-1,8	-0,3	-0,6	-0,1	-0,4	-1,9	-0,2	-0,3
EU	**-1,2**	**-0,6**	**-1,8**	**-8,7**	**-1,9**	**-1,9**	**-0,7**	**-1,9**	**-8,8**	**-1,0**	**-0,8**
Australia	8,4	8,4	7,8	4,6	10,2	-18,6	8,4	7,8	4,6	10,0	-5,3
Belarus	0,0	-0,3	-3,4	-20,9	-1,2	-2,4	-0,1	-3,2	-20,7	0,4	0,0
Canada	2,0	2,0	1,8	0,6	22,9	18,2	2,4	2,2	1,0	9,9	6,0
Croatia	0,0	0,0	-3,6	-24,3	-11,0	-10,7	0,0	-3,6	-24,3	1,3	1,3
Iceland	-2,6	-2,9	-3,0	-3,5	-3,1	-7,7	-2,8	-2,9	-3,4	-2,9	-5,6
Japan	-4,0	0,0	-1,1	-7,0	-1,0	-0,6	-0,1	-1,2	-7,1	-0,9	-0,6
Liechtenstein	-2,6	-2,6	-3,9	-11,0	-2,9	1,1	-2,6	-3,9	-11,0	-2,7	0,7
Monaco	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
New Zealand	4,7	4,7	-1,3	-35,5	-1,0	-2,2	4,7	-1,3	-35,5	-3,8	-6,4
Norway	-9,9	-7,5	-16,5	-67,6	-37,0	-34,5	-7,3	-16,3	-67,4	-38,6	-35,6
Russian Federation	-3,6	-0,4	-2,0	-11,5	-7,3	-7,5	2,7	1,0	-8,5	-0,8	-0,9
Switzerland	-3,5	0,7	0,2	-2,5	4,4	3,7	0,7	0,2	-2,5	4,8	4,2
Turkey	-0,3	-0,3	-4,8	-30,5	-4,7	-13,8	-0,3	-4,8	-30,5	-2,9	-4,8
Ukraine	-2,4	6,2	4,4	-5,6	7,5	3,0	4,0	2,2	-7,8	5,2	2,5
USA	0,0	0,0	-1,4	-9,7	-1,8	-1,5	0,0	-1,5	-9,7	-1,3	-1,1
Other AI	**-1,0**	**0,6**	**-0,9**	**-9,4**	**-1,3**	**-2,6**	**1,3**	**-0,2**	**-8,7**	**0,0**	**-0,7**
TOTAL AI	**-1,1**	**0,2**	**-1,2**	**-9,2**	**-1,5**	**-2,4**	**0,7**	**-0,7**	**-8,7**	**-0,3**	**-0,8**

[1] Only the 3.4 activities already selected by Parties for the 1st commitment period were included.
[2] All 3.4 activities were selected, not to prejudge which activities Parties will elect.
[3] For illustrative purposes, the full range (0-100%) of discount factors is shown. The eventual use of a discount factor will be subject to negotiations.

Source: JRC, IES

The different accounting options produce significantly different results for individual Parties with large impacts on the amount of emission credits that they would be allowed to issue for their total LULUCF sectors, without even taking additional mitigation actions into account.

The overall capacity of LULUCF to deliver credits appears to be rather limited for those options with a highly constrained contribution of forest management, i.e. option 0 (current rules) or option 1 with a discount factor of 85% that reduces total removals in this sector to a level equal to the current cap. For the EU this would mean that accounting for LULUCF would result in a net credit equal to -1.8% of 1990 emissions instead of the -1.2% under the current rules. For the group of other developed countries the impact is even less, although some substantial differences exist. For instance New Zealand would be allowed to account for much larger removals under option 1 with 85% discounting (-1.3 %) than with the present cap (+4.8%) whereas Japan would be able to account for substantially less (-1.1% compared to -4%).

Also the other options, options 2 and 4 would result in a modest impact on the overall total targets (all developed countries) as well on the overall EU. For the EU the impact would be anywhere between -0.8% and -1.9% of 1990 emissions depending on the option and the base period used. Similarly for the group of developed countries the impact would be anywhere between 0% and -2.4% of 1990 emissions.

While the impact of such levels of removals is large in comparison with most countries' targets under the Kyoto Protocol for the period 2008-2012, the impact is modest on the -30% reduction target as proposed by the EU for the period up to 2020.

However, it should be noted again that these figures reflect simulated actual emissions/removals without additional mitigation action.

Unconstrained accounting for forest management applied together with the current rules of gross-net accounting would lead to very large credits from the LULUCF sector in the order of -8.7% of 1990 emissions for the EU and -9.2% for the whole group of developed countries. This is equivalent to almost one third of the suggested target of -30% by 2020 compared to 1990 that the EU proposes for the whole group of developed countries. In addition, the method of gross-net accounting without applying a cap or a discount factor does not provide an accurate account of the real net carbon fluxes due to human-induced activities.

This analysis should reassure the legitimate concern regarding the risk of large LULUCF credits coming into the system solely because of partial accounting methods, potentially overwhelming the reductions needed in the other sectors.

This should allow the debate to focus on other criteria, such as the promotion of environmental integrity, the stimulation of real additional action, the ability to deal with extreme natural disturbances and the practical implementation and not simply reward business as usual trends.

In designing and negotiating future accounting rules for the LULUCF sector, the EU should be guided by the quality and integrity of the accounting methods in accordance with the following criteria:

– Mandatory rules that cover all sources of emissions under LULUCF management practices and that increase the environmental integrity of the overall LULUCF accounting system.

– Increase the effectiveness of the LULUCF sector by realistic accounting for marginal management effects on emissions and removals (net-net accounting). This would stimulate meaningful improvements in the land-use sectors (without inflating the results) rather than rewarding business as usual. It would be particularly necessary in the context of a rapidly increasing use of biomass as fuel in order to properly reflect changes in land use.

- To the extent possible, accounting rules should also provide incentives for the management of the forest products pool, including incentives for the production and use of long-lived products as well as increased recycling rates. Accounting rules for wood products need to be linked to accounting rules for emissions and removals from forests.

- Have a long term view for a sector that typically has a long term planning horizons and high inter-annual fluctuations.

- Simplify current rules and improve the quality and cost effectiveness of the reporting.

- Ensure the highest level of harmonisation in the rules in order to facilitate consistent LULUCF accounting at Community level.

The option that delivers on most of these qualitative criteria listed above is Option 4, i.e. mandatory land based accounting. It would ensure that emissions and removals for all land categories are reported . This would also put an end to the selective “cherry picking” of certain activities as is currently allowed for. It would imply a much broader coverage as all managed land would be covered on a mandatory basis. Accounting for all land would remove any perverse incentives arising from partial and inconsistent accounting rules.

- It would be a net-net approach with a base year or base period. An advantage of net-net accounting for forest management is that no arbitrarily negotiated cap or discount factor needs to be applied providing a clear incentive for countries to take mitigation action in the LULUCF sector.

- The same accounting rules would apply to all managed land, which would be a simplification .

- While reporting methods already exist under the UNFCCC that could be used for land based accounting, significant further effort will be necessary to improve the reporting practices and methods, particularly for agricultural lans. This is likely to increase uncertainties, at least in a first stage.

- Given that all land would need to be accounted for and the potentially important inter-annual fluctuations of the biological carbon sequestration which limited degree of human control, the compliance risk for Parties is likely to substantially increase..

- Uncertainties and difficulties could however pragmatically be dealt with by using a conservative approach, which would reduce the risk of overestimation of removals or underestimation of emissions and thus also the risk of ex-post adjustment and compliance issues. Furthermore, applying net-net accounting would reduce the effect of systematic uncertainties making it easier to implement a conservative treatment of uncertainties.

Difficulties that would remain for this option are the effects of natural disturbances, age structure and harvesting cycles. To support the acceptability of Option 4 its implementation needs to be accompanied by a regime allowing countries to deal with emissions due to extreme natural disturbances. Several proposals are currently on the table in relation to the treatment of natural disturbances that should be further assessed during the negotiations.

Accounting for harvested wood products would also need to be considered in the context of Option 4. The effect of age structure, if significant and substantiated, could be taken into account through target setting.

Conclusion

The risk of large sinks credits coming into the system, potentially overwhelming the reductions needed in the other sectors is limited for some of the options and can be contained for the others through appropriate capping or discounting. Therefore, almost all assessed accounting options would guarantee the minimal required environmental integrity of the overall targets.

From a quantitative and quality point of view option 4 (mandatory land-based accounting on a net-net approach) has the advantage that it delivers on most of the environmental integrity and quality criteria required for the accounting of LULUCF. This will need to be accompanied with rules dealing with the compliance risk due to extreme natural disturbances. Implementation of option 4 will also requires further improvement of LULUCF inventory data.

6.4. Accounting rules for a surplus off Assigned Amount Units

In order to assess the impact of any surplus of Assigned Amount Units over the period 2008-2012 on the environmental integrity of the reduction targets for the period after 2012, the following is assumed:

– 2008-2012 average emission levels are assumed to remain at the level of 2006 emissions

– Countries with a deficit (i.e. emission levels above the reduction target under the Kyoto Protocol for the period 2008-2012) acquire AAUs from countries with a surplus in order to be in compliance

– No credits generated through CDM are used for compliance[37], neither any emission rights generated through a net sink in the LULUCF sectors.

Table 10 gives an overview of the potential surplus or deficit per country on the basis of the above assumptions. For the group of countries that have ratified the Kyoto Protocol, the potential surplus on an annual basis over the period 2008-2012 amounts to 1.47 Gt CO_2, i.e. 1474 million AAUs or 7.4 billion AAUs over the period 2008-2012. Given that any potential inflow of credits from CDM is not taken into account, the total surplus is likely to be substantially larger.

If the USA is taken into account as a potential buyer of AAUs for compliance, the surplus would reduce substantially to 162 million AAUs per year or 811 million AAUs over the 2008-2012 period.

Table 10 Potential annual surplus or deficit of AAUs over the period 2008 - 2012

[37] Note that emission rights generated through the Joint Implementation Mechanism are actually converted AAUs and as such do not change the total amount of available emission rights.

	Target 2008-2012	Base year	1990	2008-2012 average annual emissions	2008-2012 Average annual target in absolute emissions	Average annual Surplus (+), deficit (-)
EU 15	-8%	4266	4244	4151	3924	-227
EU 10	-7%	1494	1320	979	1388	410
Russia	0%	3323	3326	2190	3323	1133
Ukraine	0%	921	922	443	921	478
Iceland	10%	3	3	4	4	-1
Norway	1%	50	50	54	50	-3
Switzerland	-8%	53	53	53	49	-5
New Zealand	0%	62	62	78	62	-16
Australia[a]	8%	516	416	536	557	21
Japan	-6%	1261	1272	1340	1186	-154
Canada	-6%	594	592	721	558	-162
USA	-7%	6135	6135	7017	5706	-1312
Surplus (+) or Deficit (-)						
Excluding the USA		12543	12261	10549	12022	1474
Including the USA		18678	18396	17566	17728	162

Source: UNFCCC GHG inventory data
http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3841.php
http://unfccc.int/ghg_data/kp_data_unfccc/base_year_data/items/4354.php

[a] For Australia, the base year data includes emissions from LULUCF according to Art. 3.7 of the Kyoto Protocol[38]

The impact of this amount of surplus AAUs on the achievement of a -30% reduction target for developed countries by 2020 is significant.[39] If it is assumed that the surplus AAUs under the Kyoto Protocol are consumed for compliance purposes at a constant rate over the period 2013-2023 by the group of all developed countries (including the USA), then a total of 737 million AAUs (= 1474 x 5 / 10) would be available each year up to 2020. This would represent 4% of 1990 emissions of this group, including the USA. As such the surplus amount

38 This figure for Australia needs to be adjusted once their AAU report is approved by the UNFCCC.

39 For the purposes of this calculation, it is assumed that the 2020 target level is the average of a five year period from 2018 to 2022, following a five year period from 2013 to 2017.

of AAUs could potentially reduce the real environmental impact of the -30% target for the whole group of developed countries, including the USA, by 4%[40].

The impact might even be higher if less surplus AAUs are used for compliance early in the period 2013-2022 and more at the end, compared to the flat rate of 737 million AAUs.

Similarly the use of CDM credits and removal units generated through the LULUCF sectors is expected to further increase the amount of surplus AAUs over the period 2008 – 2012 and thus the potential negative impact on the environmental effectiveness of a given reduction target in 2020.

If the USA had participated in the Kyoto Protocol, as foreseen when negotiation the Kyoto Protocol's reduction targets, the surplus AAUs would have had a significantly lower impact on the post-2012 reduction target, i.e. only 0.4% or on average 128 million AAUs over the period 2013-2022 (= 162 x 5 / 10).

Conclusion

Surplus AAUs from the period 2008-2012 constitute a significant risk for the environmental effectiveness of the reduction targets for the period after 2012. If this is not taken into account when setting the overall ambition level, the -30% reduction target compared to 1990 by 2020 might result in real emission reduction of only -26% or even less compared to 1990 by 2020.

6.5. Actions/technologies to achieve the reduction targets for developed countries and a substantial deviation from baseline in developing countries by 2020 and the development of the global carbon market to stimulate these actions

6.5.1. Actions to achieve the reduction targets for developed countries and a substantial deviation from baseline in developing countries by 2020

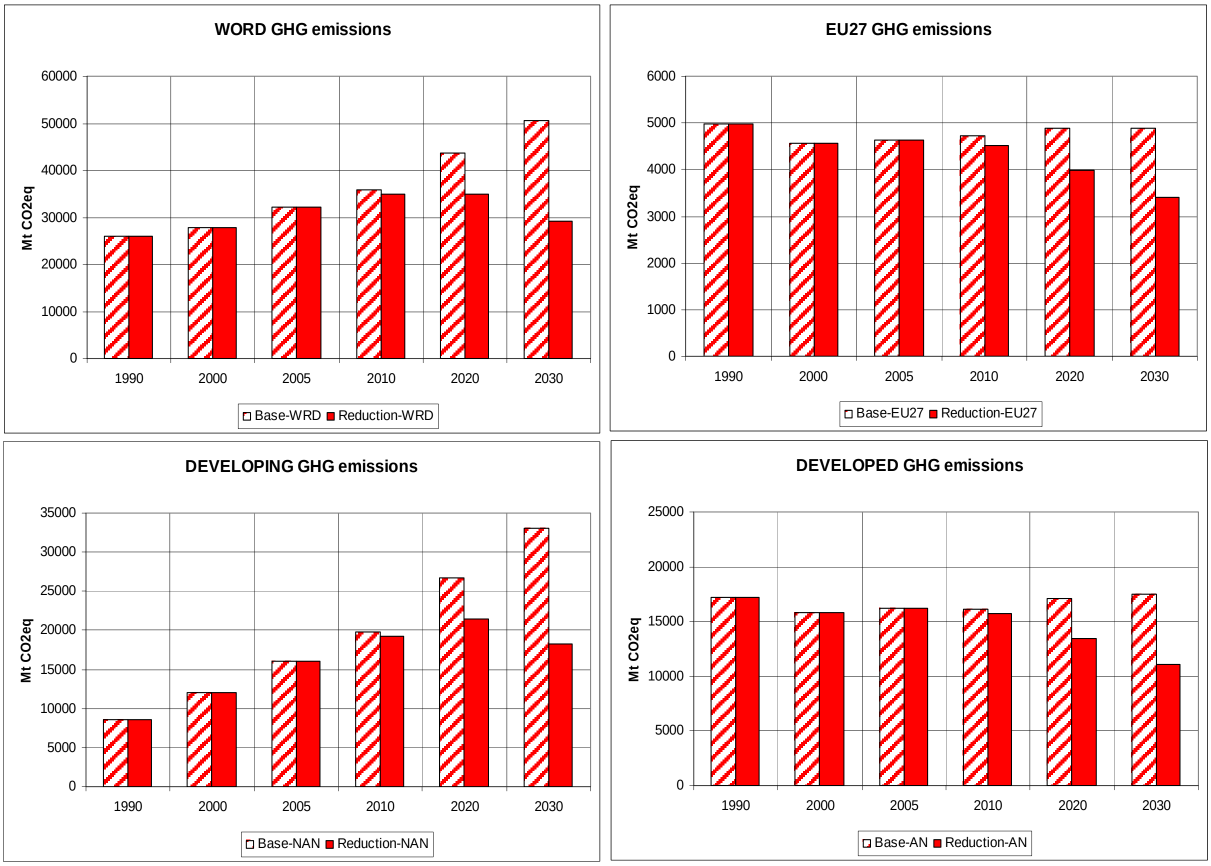
The POLES model was used to analyse the type of actions/technologies necessary in the energy and transport sector to ensure that GHG emissions are limited to be in line with the objectives proposed by the EU following the policy assumptions as presented in the policy option definition in chapter 5.4. The results are referred to as the "appropriate global action scenario".

GHG emissions in developed countries decrease by 22% in 2020 compared to 1990. Also in the EU, domestic GHG emissions decrease by 20%. The remaining 10% is achieved through offsetting mechanisms that generate credits for reductions in developing countries. GHG emissions of developing countries continue to grow up to 2020, but reach a peak between 2020 and 2025. In 2020, emissions from energy and industry in developing countries are 19% below baseline projections. See Annex 12 of this Staff Working Document (Part 2) for more details for the major economies.

Figure 5 Developed/developing countries GHG emissions in POLES baseline & appropriate global action scenario[41]

[40] Note that if the USA is not taken into account, the annual amount of 737 million AAUs used for compliance over the period 2013-2022, would represent 6% of 1990 emissions.

[41] See in Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.



Source: JRC, IPTS, POLES

Action on energy efficiency, crucial contribution to the appropriate global action scenario

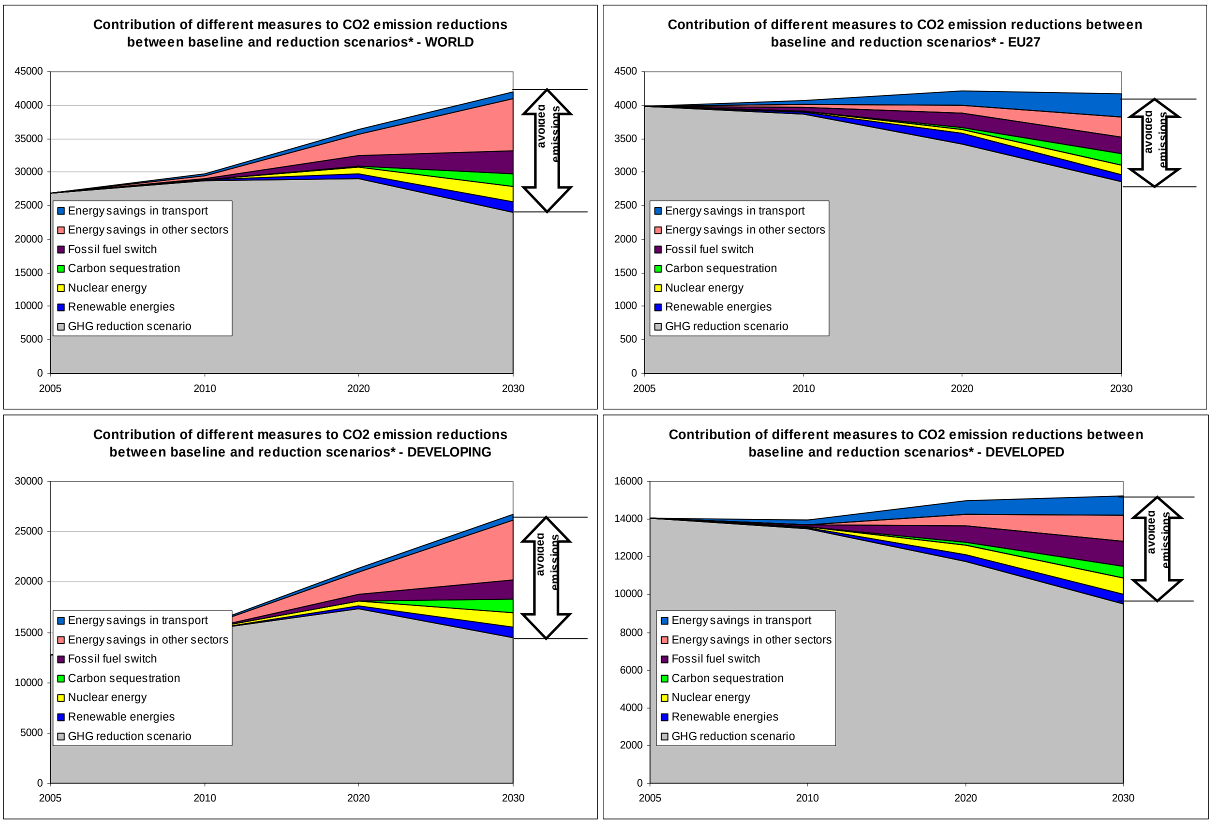
Until 2020, energy efficiency measures represent the bulk of the reduction potential, both technically and economically. It is the single most important opportunity in the coming decade.

A large variety of low-cost measures can be exploited, most of which are already available and have negative or low costs even though upfront investments might be considerable. All sectors have options to improve energy efficiency (both supply and demand sectors). The POLES model simulates the realisation of this reduction potential through improving the global energy intensity through such policies at no or low cost.

Moreover, the gradual introduction of a carbon price at higher levels than the one assumed in the baseline stimulates further carbon price-induced energy efficiency improvements.

The figure below shows the crucial importance of such induced energy efficiency improvements for the overall emission reductions, delivering up to 50% of total global effort compared to baseline in 2020 at no or very low cost. In 2030 it would still a little less than half the global effort. For developing countries this share is even higher at 2/3rd of the total action.

Figure 6 Contribution of different technologies to reduce CO2 emissions[42]



Source: JRC, IPTS, POLES

Annex 11 of this Staff Working Document (Part 2) gives more detailed background to exactly what types of energy efficiency actions can be taken in what regions and in what sectors.

Renewable energy

Renewable energies are not only carbon free, but also improve the security of supply within energy balances. Most of them are particularly relevant for power production (hydropower, on- and off-shore wind power, solar PV, high temperature solar, geothermal, different types of biomass-fed power plants, and in perspective geothermal, tidal and wave power). They present often zero or very low GHG emissions. They are available at a wide range of development levels, from commercially mature to those that are only at the conceptual stage. Particularly innovative are some technologies to improve the performance of photovoltaic cells, but also biotechnologies for biofuels or hydrogen production. These still need important R&D efforts. Other technologies, close to commercial stage, are struggling to compete and need support schemes but they would do well in a world with a price of carbon. The baseline scenario foresees that electricity output from renewables would grow worldwide by 148% by 2020 and by 246.8% by 2030 with respect to 1990, whereas renewables would increase by 185.4% by 2020 and by 322.4% by 2030 in the Appropriate Global Action scenario for the same period. The potential growth of each technology, however, depends on the remaining potential. Hydropower, for instance, offers limited expansion capacity in many developed

42 See Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.

regions, and by 2030 the hydropower output differences between the two scenarios are small, around 5% with respect to the reference year (that is, an 85.3% increase in the Appropriate global action scenario versus an 80.3% increase in the Baseline). 'New' renewables (mainly wind and to a lesser extent solar), are expected to grow by 2329.1% above 1990 levels in the Baseline and by 3298.7% in the Appropriate global action scenario by 2030. These changes look impressive but in fact they represent in the baseline scenario a yearly growth rate of 8.8% until 2020 and of 8.3% until 2030, and in the Appropriate global action scenario slightly higher yearly growth rates (10.0% until 2020 and 9.2% until 2030). The real acceleration takes place in the period 2005-2020, when production increase more than sevenfold in the baseline more than tenfold in the Appropriate global action scenario.

For the EU renewables growth in power generation would be 272,2% in 2020 and 331.1% in 2030 with respect to 1990 in the Appropriate scenario (against 221% and 310.4% in the baseline for the same period). The growth in "new" renewables, excluding hydropower, would be much faster, with rates close to 13.4%/yr to 2020 and 10.6%/yr to 2030 in the Appropriate scenario.

Total growth in renewables allows to reach a share of 17% over total primary energy by 2020 and 18,3% by 2030. They represent respectively 17% in 2020 of total final energy consumption[43]

Renewables have also an important market niche in non-electric applications. In domestic and industrial sectors, low temperature solar thermal devices and biomass-fuelled boilers can be used. In the transportation sector, bio-ethanol, bio-diesel or other forms of sustainable biofuels are also already extensively used in several countries, and in some of them have gained a significant market share. Their worldwide potential is significant. This assessment addresses the increased demand for sustainable biomass and biofuels and its potential impact on deforestation and agricultural production in chapter 6.6.

Nuclear power

Another carbon free energy source is nuclear power. In the baseline, worldwide nuclear power sees a 40.6% capacity increase and a 40.1% output increase over the period 2005-2020. This is higher than in the 2007 IA[44]due to higher overall fossil fuel prices. In the Appropriate global action scenario more nuclear power capacity is added, with an 80.9% increase of installed capacity and an 80.5% increase in output by 2020 compared to 2005. Over half of total additional capacity would be installed in developing countries.

In the EU, capacity is roughly maintained in 2020 at 2005 levels in both scenarios in line with current phase-out plans in Member States.

Fuel switch

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43 This translates into a 17% renewables share of final energy demand. The figure does not include the contribution of heat-pumps in Residential and Services surface heating, geothermal, tidal and wave energy. Heat production for local CHP plants based on biomass is not considered in the model. If these sources would be incorporated in the calculation, the renewables share would increase towards the 20% target. See also the results of the Green-X model used for the staff working document accompanying the Renewable Road Map Communication on the estimations of the excluded sources (COM 2006/1719).

44 Impact assessment accompanying the Communication "Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond"

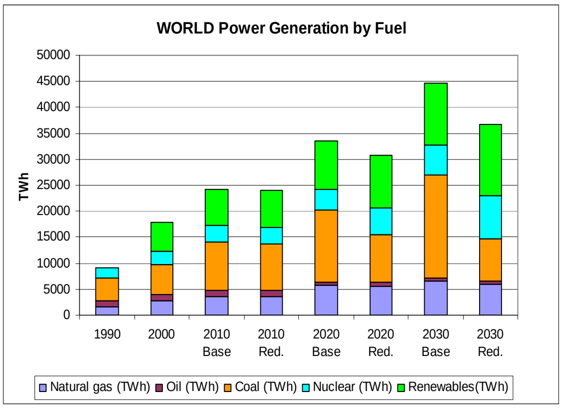
Fuel switch very often entails not only changing to a less carbon-intensive fuel but also additional gains in efficiency because the fuel change implies a substantial change in technology (e.g. replacing oil-fired boilers with advanced high-efficient gas turbines). However, this is not always the case, since some standard combustion plants can accommodate a range of fuels from highly carbon intensive coal to virtually zero-carbon biomass. The power generation sector is the one, at global scale, that would experience most of the fuel switch in the projected period due to its relatively high technological flexibility.

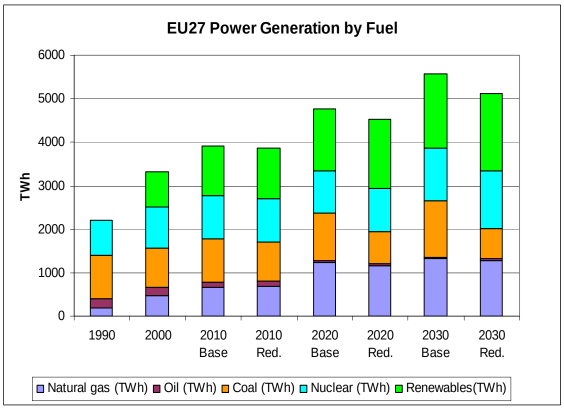
It is interesting to note that the upward trend in the demand for electricity is much higher compared to the projected increase in overall final energy demand, i.e. the share of electricity will increase. Electricity will continue to be the most valued and demanded final energy carrier, and even in the Appropriate global action scenario total electricity demand grows by 160% by 2030 with respect to the 1990 level. However, the technological portfolio is expected to radically change, carbon-free primary electricity is supposed to account for around 55-56% of total electricity produced by 2030 (both worldwide and in EU-27) in the Appropriate global action scenario, whereas in the baseline this share is expected to reach a mere 33.6% worldwide and 47,7% in the EU.

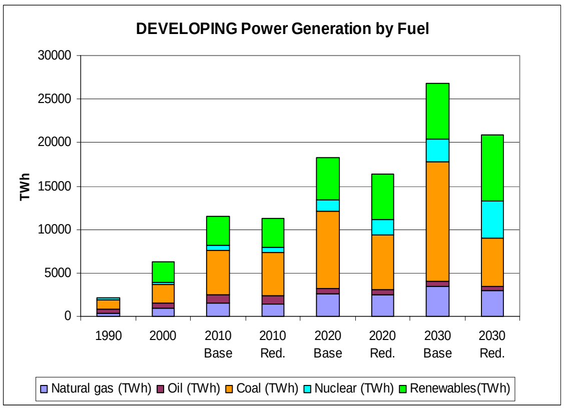
It should be noted that since 1990 the share of carbon free electricity produced globally has dropped significantly. This is due to the huge growth in fossil fuel power generation capacity (particularly coal-fired), and to the slowdown or outright halt of nuclear programmes worldwide over the last two decades. The Appropriate global action scenario will take the world back in terms of share of carbon free electricity almost exactly to the share as it stood in 1990. The scale, of course, will be 3.5 times bigger than in 1990.

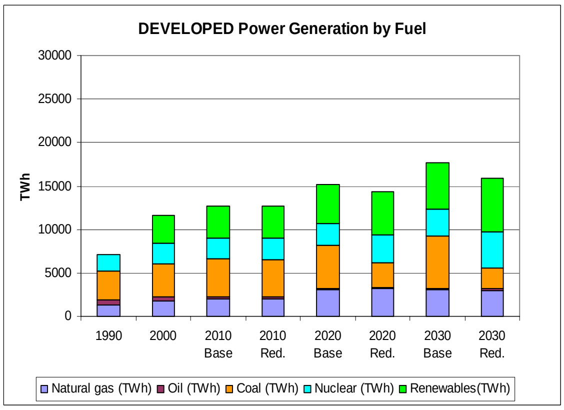
Figure 7 Power Generation by fuel type[45]

[45] See in Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.









Source: JRC, IPTS, POLES

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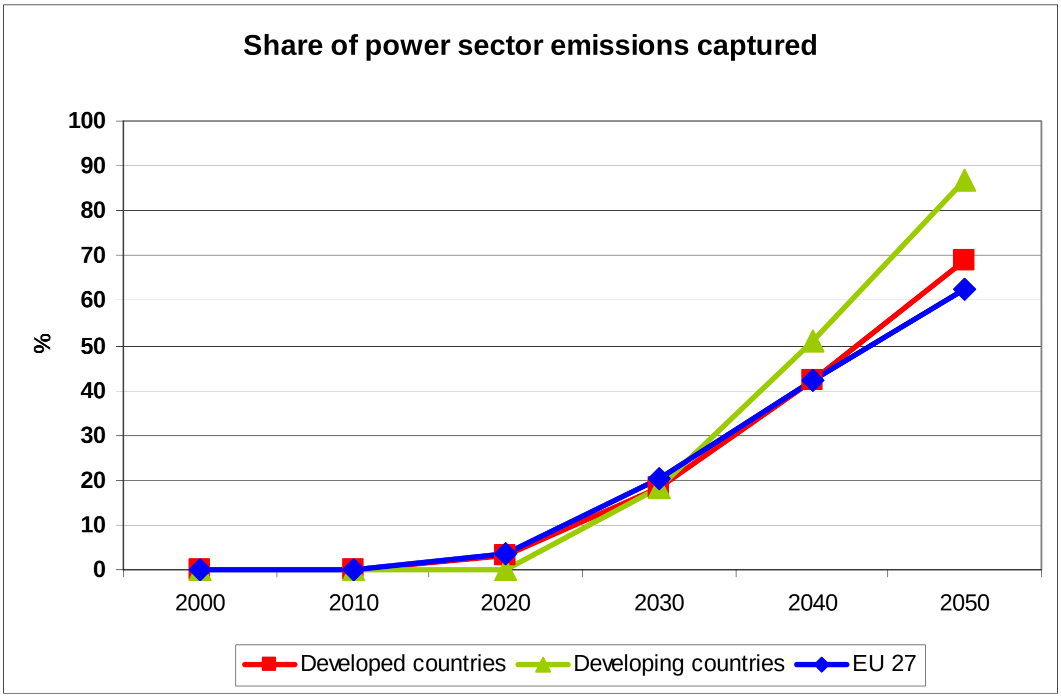
Carbon Capture and Storage

From the point of view of new technologies, a significant contribution to emissions reductions is expected from CCS. In fact a very fast deployment of this technology would be necessary from the very low current levels to those projected for 2030 in the Appropriate global action scenario. This technology is already being used especially in the context of enhanced oil recovery and natural gas production but the marginal costs for retrofit applications is still significantly higher than prevailing carbon prices. Furthermore, the environmental impact of large scale deployment of this technology in the power sector over very long periods is largely unknown. The environmentally sound and safe deployment of this technology requires a sound legal framework like the one that has been adopted by the European Union.

Unsurprisingly, at global level, in the Baseline, the penetration of CCS with respect to fossil-fuelled power plants by 2030 is virtually zero, whereas the Appropriate global action scenario results in a significant share of fossil fuel power generation with CCS (18%). This underlines how crucial this technology will be in the future to achieve a sustainable carbon emission path at global level, and that large scale demonstration has to commence without delay. The greatest potential for expansion of this technology is anticipated to take place in the US and in

China, while it would be relatively smaller in the EU. Most new fossil fuel power plants built after 2020 would be with CCS.

Figure 8 Share of power sector emissions captured through Carbon Capture and Storage



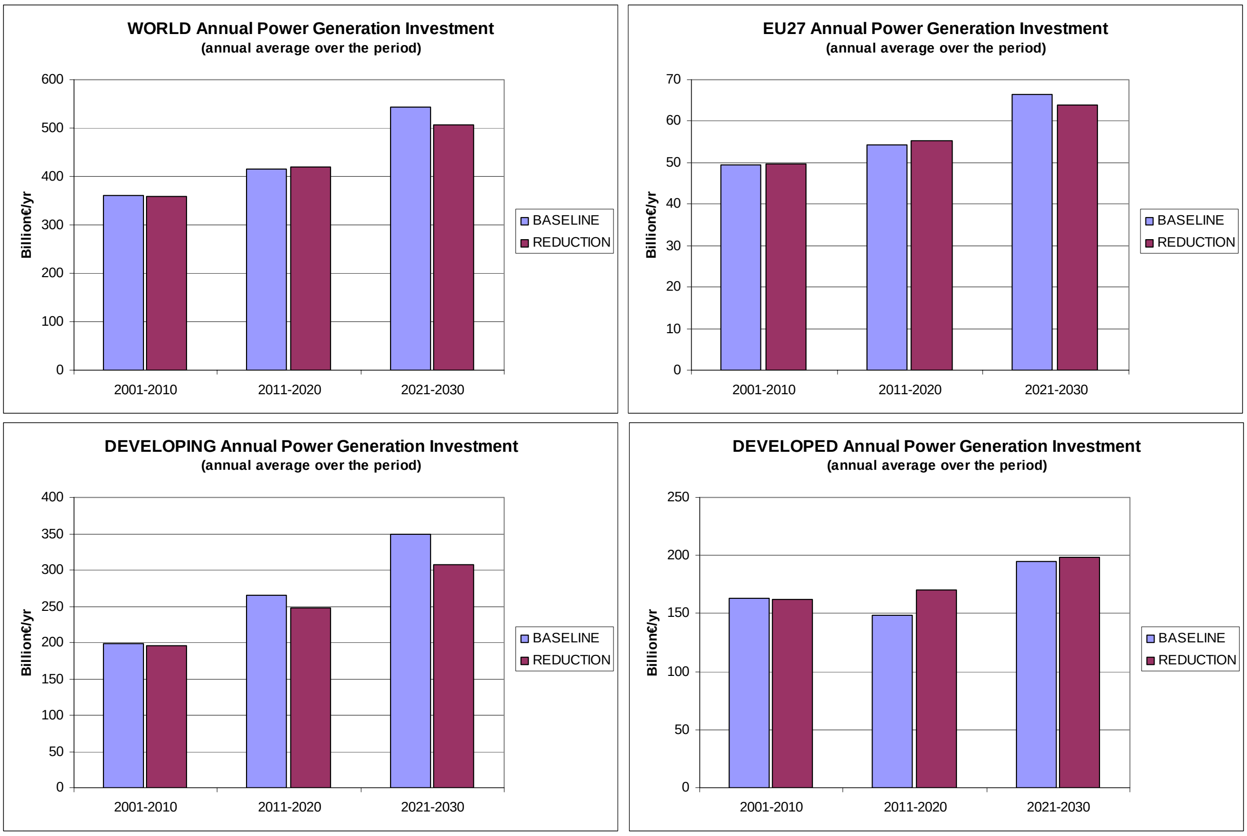
Source: JRC, IPTS, POLES

Investment needs in the power sector

The Appropriate global action scenario implies an accelerated decommissioning of carbon-intensive technologies and its replacement by low-carbon, climate-friendly ones. The latter typically exhibit higher investment costs, therefore higher investment flows are required. However, while the costs of single investments are higher, a carbon constrained world also entails more efficient end-use of energy and therefore a lower total final energy demand requiring less power plants overall. This affects all final energy carriers, but most especially the power generation sector, which is the one expected to contribute a significant share to the overall decarbonisation of the energy sector. The annual investment in newly installed capacities for the power sector (26 power generation technologies are considered) is shown hereafter for both scenarios until 2030. For CCS installations, this investment cost includes the costs to capture CO2 but not to transport and store it. As such total investments including CCS might be higher in 2030 due to a large penetration of CCS by then.

Figure 9 Annual Power Generation Investments[46]

[46] See in Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.

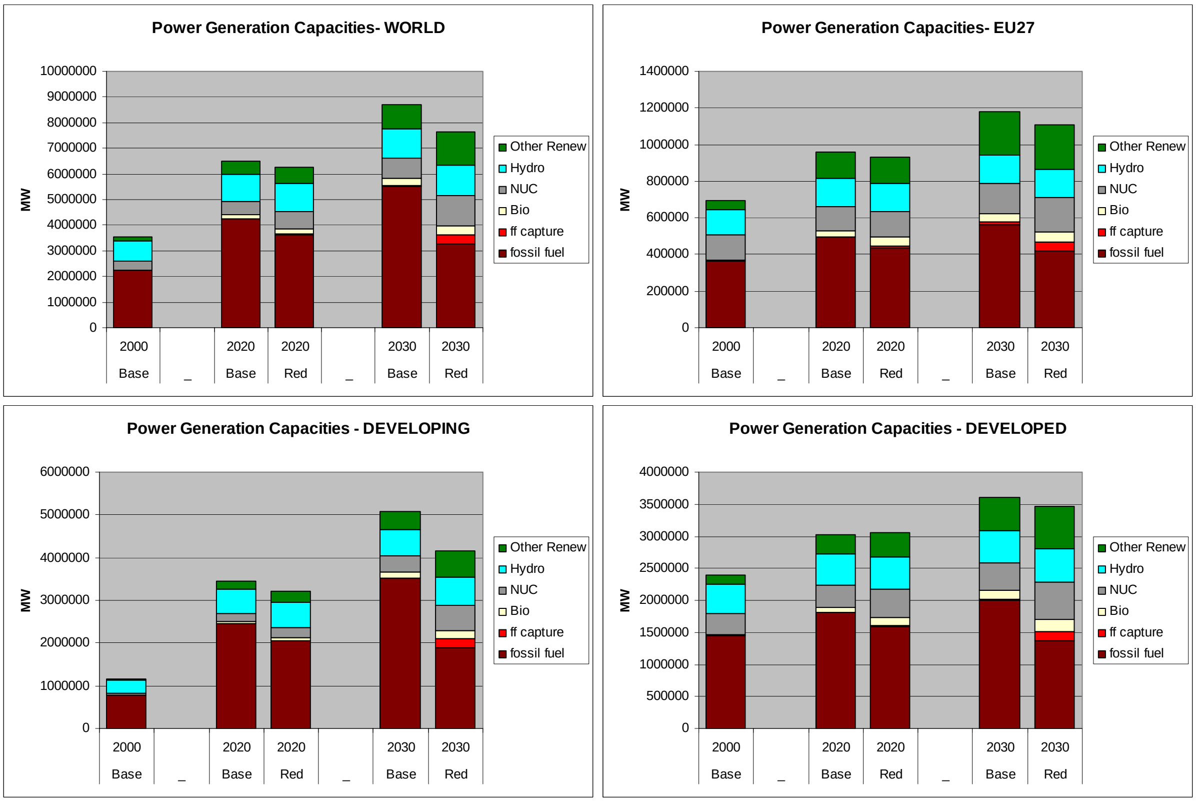


Source: JRC, IPTS, POLES

The results indicate that the differences in costs within the power generation sector are not very high because efficiency gains are projected to offset higher specific capital investment costs.

Figure 10 Changes in the mix of power generation[47]

[47] See in Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.

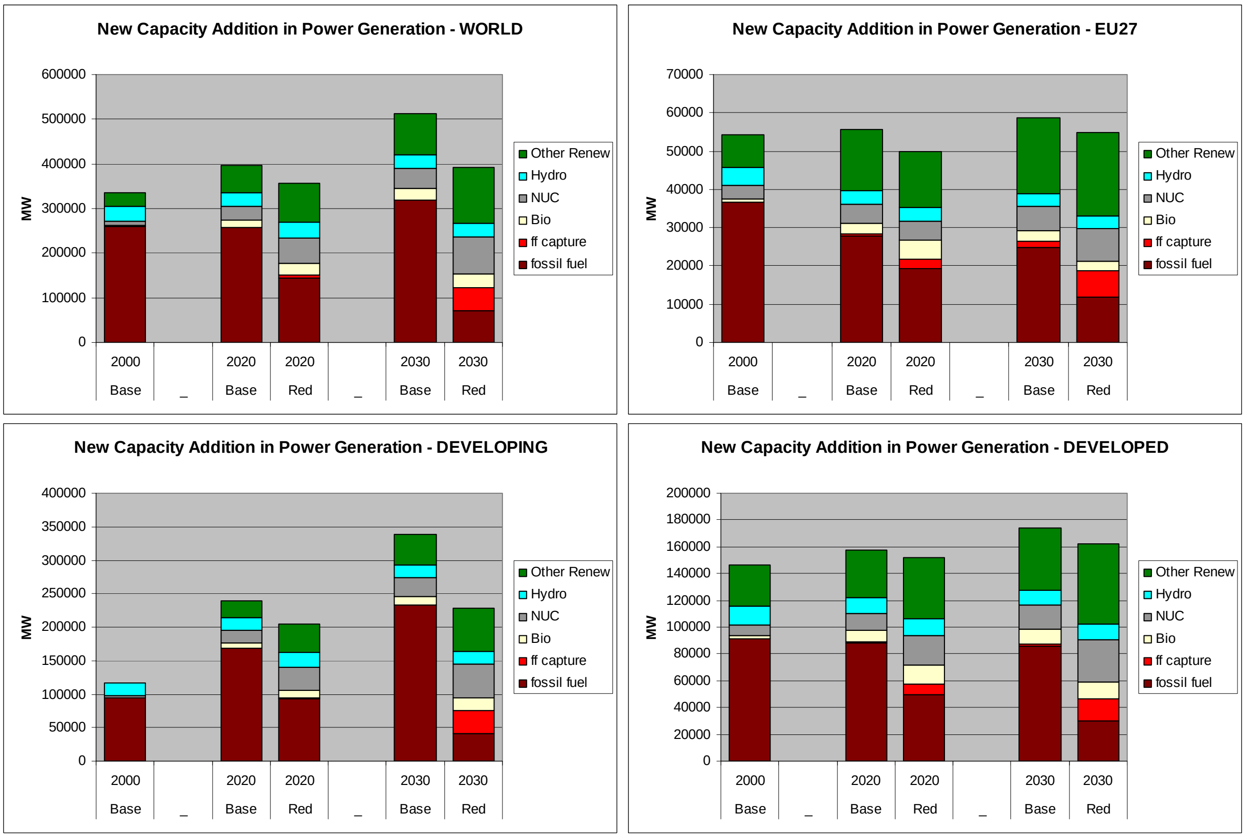


Source: JRC, IPTS, POLES

The main changes in generation capacity between the Appropriate global action scenario and the baseline would concern the thermal-electric power from fossil fuels. Worldwide it would decrease by around 41% in the Appropriate global action scenario by 2030, but the impact until 2020 would be much smaller. This trend is particularly obvious in China, India and the US. But the losses of fossil fuelled generation capacity would be to a large extent substituted by increases in renewables and nuclear capacity. Additional capacity in developed countries would be provided mainly by new renewables and hydro. Nuclear would also grow in all regions.

Figure 11 Additional, new capacity in Power generation compared to 2000[48]

48 See in Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.



Source: JRC, IPTS, POLES

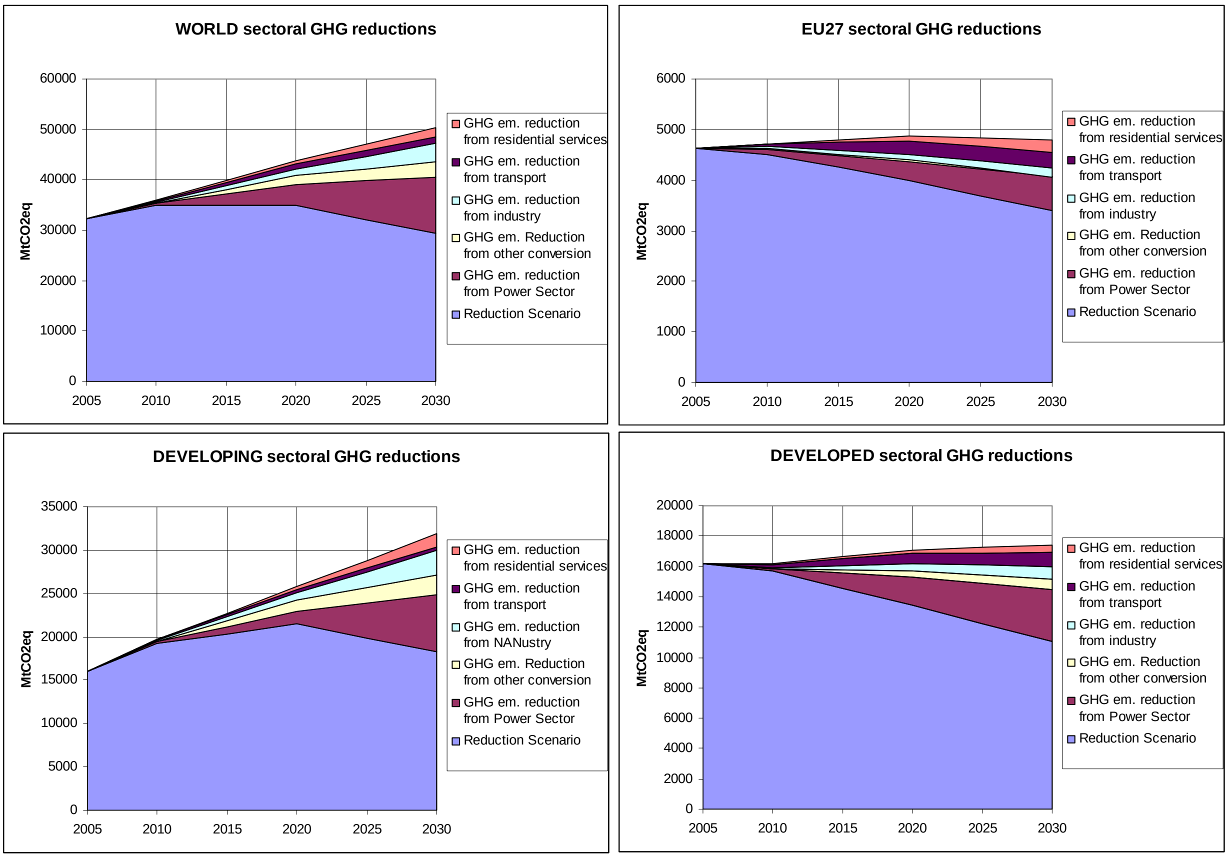
Sectoral contributions to the appropriate global action scenario

The structure of energy-based and industrial GHG emissions provides an insight on the different opportunities of emission cuts by sectors. More than half of the potential emission cuts are to be found within the power generation sector. This reflects the great potential of this sector to shift to less carbon intensive technology portfolio combined with the possible reductions on the demand side. The industrial sector follows, where significant opportunities can also be found. This emission reduction potential is particularly important in developing countries, so that the power generation and industrial sectors in these economies appear to be the key sectors for GHG abatement actions in the future international agreement.

Sectors like residential and transport exhibit lower rates of technological change as private persons might lack sufficient cash to purchase energy efficient goods at optimal levels due to sometimes high upfront investments (e.g. energy efficient household equipments or better thermal insulation of houses).

Figure 12 GHG reductions per sector, World Regions[49]

[49] See Annex 12 of this Staff Working Document (Part 2) for more details on impacts of the Appropriate global action scenario on selected MEM participants.



Source: JRC, IPTS, POLES

Costs associated with the resulting actions necessary in the energy system and the industrial sectors

The real incremental mitigation costs that are experienced within an economy induced through carbon prices and the upfront investments necessary to achieve energy efficiency measures are estimated by the POLES model and can be found in Table 11. They do not include the financial flows generated by the trade in emission reduction credits, even though developed countries only reduce by around -22% by 2020 compared to 1990 so around 8% further reductions would have to be achieved through acquisition of credits through the use of offsetting mechanisms.

The annual global reduction costs in the year 2020 amount to € 152 billion by 2020. Over the whole period 2013-2020 cumulative global costs are equal to € 666 billion. Costs in developed countries are equal to € 81 billion in 2020 or € 374 billion cumulated over the period 2013-2020. Costs in developing countries are equal to € 71 billion in 2020 or € 292 billion over the period 2013-2020.

Table 11 Costs in developed and developing countries

	Cost of reductions in CO2 from energy and Non CO2 emissions from industry	
	Costs in the year 2020	Total costs over the period 2013 – 2020
	Total costs in Billion € (2005 prices)	Total costs in Billion € (2005 prices)

	(a)	(c)
World	152	666
Developed countries	81	374
Developing countries	71	292
EU	23	126
USA	34	157
Japan	7	30
Russia	7	22
China	30	109
Brazil	3	14
India	5	24

Source: JRC, IPTS, POLES

– Annex 13 of this Staff Working Document (Part 2) discusses in more detail the type of policies and institutional architecture within the international agreement on climate change could deliver the type of actions in developing countries as indicated in this chapter.

– Annex 14 of this Staff Working Document (Part 2) gives further information on the issue of sectoral approaches and how they relate to type of actions in developing countries as indicated in this chapter.

– Annex 15 of this Staff Working Document (Part 2) gives further information on the issues related to technical cooperation and how they can assist with actions in developing countries as indicated in this chapter.

Conclusions

– Actions in the energy system and industrial sector on a truly global scale are crucial to ensure that the 2°C limit can still be met.

– Little more than half of the reduction potential compared to baseline in the energy system and in the industrial sectors comes from measures that have no or low cost on the short and mid term. In developing countries this is even 2/3rd of the total. They still have substantial upfront investment cost. This can be a hurdle for those who do not have the financial capacity.

– Energy efficiency has by far the single largest potential to reduce emissions .

– But there is no single silver bullet technology. Next to energy efficiency improvements, there is need to also use more low carbon energy sources (renewables & nuclear), to switch to lower carbon content fossil fuels, and gradually after 2020 implement CCS for all large remaining point sources, certainly those newly build.

6.5.2. The role of the carbon market

The three options as presented in chapter 5.4 are analysed using the POLES and GEM E3 model.

Option 1: Gradual global carbon market

For the gradual global carbon market we take the same scenario as the "Appropriate global action scenario" presented in chapter 6.5.1 with the policy assumptions already presented in chapter 5.4 With these assumptions GHG emissions in developed countries decrease by 20% in 2020 compared to 1990 by 2020. This of course means that the remaining 10% of their -30% target needs to be achieved through offsetting mechanisms in the global carbon market.

Option 2: No global carbon market

For this option it is assumed that the developed countries need to reach the -30% target domestically. The carbon prices in the POLES model are increased step by step until the group of countries meets the -30% target in 2020 compared to 1990. This results in the cost effective outcome to reduce -30% within the group of developed countries.

At the same time, carbon prices in the developing countries are decreased to such an extent that total global emissions remain the same as in the case of the option gradual global carbon market and in line with the 2ºC objective.

Option 3: Perfect global carbon market

This option ensures that global emissions stay the same as in the case of the option gradual global carbon market but this time all carbon prices (in all sectors and all countries) are equalised assuming no transaction costs[50].

Assessment of the costs of the different options of the global carbon market using the POLES model

The table underneath gives an overview of the real mitigation costs incurred, i.e. not representing any financial transfers due to trade flows in emission rights. They also give costs for some of the key countries. The figure underneath represents the carbon prices as experienced in the different scenarios for the ETS-type of sectors in the different regions.

Columns (a) to (c) in the table give the projected internal reduction cost experienced in 2020 while columns (e) to (g) give the cumulative costs over the period 2013 to 2020. Costs on a global scale are lowest for the option of the perfect carbon market. But also in the gradual carbon market scenario, costs are substantially lower compared to the case where developed countries achieve the -30% domestically.

In the perfect market case costs increase for developing countries. Also the costs expressed as a % of GDP are highest for developing countries in the perfect market case while for developed countries they are highest in the case of no global market.

Carbon prices in developed countries range from € 72 per ton of CO2 in case of the need to achieve the 30% internally to € 22 per ton of CO2 in the case of a perfect global carbon market, with € 44.5 per ton of CO2 as a price level in case of the gradual carbon market.

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[50] Note that in the baseline already a carbon price is included in the EU and other developed countries. It is assumed that this carbon price is not lowered, even if in a optimal global perfect carbon market prices would go below these carbon prices assumed already in baseline. See chapter 6.1 for a detailed description of the baseline.

Table 12 Impact of gradual development of the carbon market, POLES

	Total costs 2020 (Billion €, 2005 prices)			Total costs period 2013-2020 (Billion €, 2005 prices)			Relative % costs per GDP, compared to world average		
	No global carbon market	Gradual global carbon market	Perfect global carbon market	No global carbon market	Gradual global carbon market	Perfect global carbon market	No global carbon market	Gradual global carbon market	Perfect global carbon market
Carbon price per ton CO2 in developed countries ETS, 2020	72,2 €	43,6 €	22.0 €						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
World	213	152	113	996	666	500	100%	100%	100%
Developed countries	166	81	39	755	374	179	173%	119%	76%
Developing countries	48	71	75	241	292	321	41%	85%	120%
EU	47	23	12	249	126	66	136%	94%	66%
USA	68	34	16	318	157	72	185%	129%	83%
Japan	15	7	3	60	30	13	139%	93%	54%
Russia	17	7	3	51	22	12	265%	159%	97%
China	18	30	30	86	109	121	40%	92%	124%
Brazil	2	3	3	11	14	15	43%	87%	119%
India	5	5	8	23	24	34	24%	36%	84%

Source: JRC, IPTS, POLES

The above table clearly confirms that a gradually developing carbon market reduces global reduction costs substantially. But in order to estimate overall costs per region, both mitigation costs of reducing emissions from energy and non CO2 in industry (see table above) and potential costs and revenues related to trade flows in the carbon market need to be taken into account.

For the assessment of potential trade flows, economy-wide mid-term targets (QELROs) were allocated to developed countries that create the demand for emission reduction credits from developing countries and were applied on the gradual carbon market scenario, or also called the "Appropriate global action scenario" as presented in chapter 6.5.1.

For this assessment it is assumed that developed countries have a reduction target as indicated in chapter 6.2 based on the option using a composite of four indicators (see Table 5 for target setting approach).

The table below shows the result of the domestic emissions reductions in some key developed and developing countries for this scenario and compares this for the developed countries with the targets as suggested in Table 5.

Table 13 Reductions in developed and developing countries and trade in emissions rights

	2020 target vs1990 emissions	Achieved domestic reduction in 2020 vs 1990 emissions	Amount bought (+) or sold (-) in 2020 via the carbon market as a % of 1990 emissions	Reduction in 2020 vs baseline emissions	Amount sold via carbon market as % of baseline emissions
Developed countries	-31%	-22%	9%		
EU	-30%	-20%	10%		
USA	-24%	-9%	15%		
Japan	-24%	-6%	18%		
Russia	-38%	-46%	-8%		
Developing countries				-19%	-6%
China				-20%	-6%
Brazil				-20%	-6%
India				-13%	-4%

Source: JRC, IPTS, POLES

In the appropriate global action scenario, developed countries would decrease their domestic emissions by around 22% compared to 1990 and thus need to acquire an amount of emission credits which is equal to 8% of their 1990 emissions. Developing countries reduce their emissions compared to baseline by around 19%, of which 6% can be sold through the carbon market (6% of 2020 baseline emissions of developing countries is equal to 8% of 1990 emissions in developed countries). This means that still 13% of reductions in developing countries would need to come from autonomous actions that are not directly supported by the carbon market. Around two third of this 13% can be achieved through measures at low carbon value or even negative costs ('win-win') in the short to mid term.

The table underneath gives an overview of the costs incurred by different key countries. Columns (a) and (b) represent the domestic reduction costs, while columns (c) and (d) take into account any additional costs from acquiring emissions credits on the carbon market or revenues from selling emission credits on the carbon market.

The transfers on the carbon market represent in total € 51 billion, including trade between developed countries. Trade between developed and developing represents € 38 billion. Developed countries benefit substantially from this trade with developing countries. Even though the acquisition of the credits costs them € 38 billion, they reduce their mitigation costs by € 85 billion from € 166 billion in case of no trade at all (see Table 12) to 81 € billion in case of trade. This represents a net gain of € 47 billion.

Table 14 Costs in developed and developing countries and trade in emissions rights

	Average annual cost of reductions in CO2 from energy and Non CO2 emissions from industry in 2020	
	Not taking into account revenues or expenditure for carbon trade in 2020	Taking into account revenues or expenditure for carbon trade in 2020

	Total costs in Billion € (2005 prices)	Cost per GDP compared to world average	Total costs in Billion € (2005 prices)	Cost per GDP compared to world average
	(a)	(b)	(c)	(d)
World	152	100%	152	100%
Developed countries	81	116%	119	170%
Developing countries	71	86%	33	40%
EU	23	94%	37	150%
USA	34	129%	57	216%
Japan	7	93%	13	176%
Russia	7	159%	-3	-75%
China	30	92%	12	38%
Brazil	3	87%	2	51%
India	5	36%	4	30%

Source: JRC, IPTS, POLES

In the scenario with no global market at all, it was assumed that developed countries reach their -30% target and developing countries would also undertake appropriate own actions that would see global emissions in line with a 2°C scenario[51]. The cost of this appropriate action is equal to € 48 billion in developing countries (see Table 12). The gradual introduction of a carbon market in developing countries is assumed to pay only for offsetting for those credits that are generated for emissions beyond the appropriate action. The price paid is assumed to be equal to the highest experienced marginal abatement cost within the developing country's region that is selling credits, which is still below the carbon price in developed countries.

These offsetting mechanisms lead to further emission reductions in developing countries, consequently increasing the costs in developing countries from € 48 billion to € 71 billion. But for this cost increase of € 23 billion, developing countries receive revenues worth € 38 billion. In this way, emissions trading creates a significant rent of € 15 billion over and above the emission reduction costs. This rent can be used to pay also partly for the costs of the appropriate own action which is estimated to amount to € 48 billion. Subtracting the rent only around € 33 billion will have to be paid for by developing countries themselves or through other additional support mechanisms.

This is a very important positive consequence of a well designed gradual carbon market. Future offsetting mechanisms should ensure that it only compensates for those reductions that are not 'low or negative' cost. In addition, it needs to go well beyond mere crediting of offsets compared to baseline, ensuring that the mechanism recycles rents from the trade in order to compensate for those emission reductions that do not generate credits.

Assessment of the macro-economic costs of the different options of the global carbon market using the GEM E3 model

[51] Assuming that action on REDD and agriculture is also undertaken as described in chapters 6.6 that lead to a deviation from baseline in total between 15 and 30%.

The macro-economic impacts of the same carbon market options as before will be assessed.

No global carbon market

For this option it is assumed that the developed countries reach the -30% target internally. The target used for developed countries are those developed in chapter 6.2 using a set of 4 indicators (see Table 5).

For the developing countries it was assumed that they would also introduce internal actions to ensure global emissions are on a pathway stay within the 2ºC objective, i.e. that emission growth would be limited to a level of around 20% above 1990 levels. In order to determine the level of appropriate action by developing countries in this scenario, similar indicators were used as in chapter 6.2

– GDP per capita, addressing the capacity to pay for emission reduction within a country

– GHG per GDP, addressing the opportunities to reduce GHG emissions

– Projected Population trends over the period 2005 – 2020, recognising different pressures on the projected emission evolution.

The higher a country's GDP per capita, the more national actions it would need to undertake to limit emissions growth compared to baseline. The higher a country's GHG emissions per GDP, the more it would need to undertake action to limit emission growth compared to baseline. And finally, the higher a county's projected population growth rate up to 2020, the less mitigation action it would need to undertake. It actually would be allowed to increase emissions compared to baseline. Summing up the three factors up will result in the necessary emission limitations below the baseline.

The table underneath gives an overview of the implication of each indicator on the total amount or reduction needed compared to baseline in this internal action scenario for China, Brazil and India. Brazil being the richest of these three countries would need to limit emissions most according to its GDP/Capita. But for Brazil the reverse is true for GHG intensity of its economy, where it is one of the better performers. Finally, India has a high population growth rate while that of China is very low resulting in a different amount of allowed increase compared to baseline. In total, China is expected to reduce more than the other two compared to baseline.

Table 15 Resulting allocation of mitigation efforts compared to baseline for key developing countries (in % compared to baseline)

	Share according to GDP/cap	Share according to GHG/GDP	Share according to Population ’05-‘20	**Target relative to Baseline**
Brazil	-13.2%	0.0%	3.9%	-9%
China	-4.2%	-13.0%	1.0%	-16%
India	-0.5%	-12.2%	4.9%	-8%

A gradual developing carbon market

This scenario is identical to the scenario presented in chapter 6.2, with a gradually developing carbon market and targets for developed countries as presented in the chapter based on the 4 indicators and with an amount of appropriate action by developing countries as presented just above.

A prefect carbon market

This scenario is identical to the scenario presented just above with the only difference that the carbon market does not develop gradually but equalises immediately on a global scale across sectors and countries

The table underneath represents the results for the 3 scenarios.

Table 16 Impact of gradual development of the carbon market, GEM E3

	Welfare compared to baseline			GDP compared to baseline		
2020	Perfect market	Gradual market	No market	Perfect market	Gradual market	No market
EU27	-0.7%	-1.4%	-1.4%	-0.4%	-1.2%	-1.5%
USA	-0.5%	-0.7%	-0.7%	-0.4%	-0.8%	-1.0%
Japan	-0.3%	-0.6%	-0.6%	-0.3%	-0.6%	-0.7%
CIS	-1.3%	-1.4%	-1.7%	-2.7%	-3.0%	-2.1%
China	0.5%	0.3%	-0.2%	-1.4%	-0.8%	-0.5%
Brazil	0.0%	-0.1%	-0.2%	-0.5%	-0.4%	-0.2%
India	0.1%	-0.2%	-0.4%	-1.4%	-0.5%	-0.5%
World	0.2%	-0.7%	-0.8%	-1.1%	-0.9%	-1.0%
	GHG Emissions compared to baseline			GHG Emissions compared to 1990		
2020	Perfect market	Gradual market	No market	Perfect market	Gradual market	No market
EU27	-6.3%	-20.9%	-25.3%	-8.5%	-22.8%	-27.1%
USA	-20.9%	-31.6%	-37.7%	-1.0%	-14.3%	-22.0%
Japan	-14.8%	-23.9%	-31.0%	-7.4%	-17.3%	-25.0%
CIS	-24.9%	-26.1%	-20.4%	-46.7%	-47.5%	-43.5%
China	-32.9%	-20.8%	-16.2%	70.3%	100.9%	112.6%
Brazil	-18.8%	-12.3%	-9.3%	80.7%	95.2%	102.0%
India	-23.5%	-10.7%	-7.8%	143.1%	183.6%	192.9%
World	-21.4%	-21.4%	-21.4%	18.3%	18.3%	18.3%

Source: JRC, IPTS, GEM-E3

This modelling run confirms that a perfect global carbon market would minimise welfare impact for all key regions. Also the gradual carbon market performs better than no carbon market. What is interesting to note is that the perfect carbon market does not improve GDP for the developing countries. The reason for that is that due to the transfer of credits, consumers in developing countries receive a higher income which they decide to spend rather on more consumption and leisure, as such maximising welfare but therefore not GDP growth.

Taking into account the gradual emissions trading flow results in affordable impacts on GDP for all key countries.

Conclusion

- Global carbon markets decrease costs significantly to achieve a certain environmental target cost efficiently, even if targets are 'fairly' allocated.

- Offsetting mechanisms should only compensate for reductions over and above low cost options. Otherwise windfall profits are created for those selling the credits.

- Offsetting mechanisms, if well designed, can compensate also for reductions that do no lead to credits. These types of offsetting mechanisms go beyond mere crediting of reductions below a baseline that does not include own appropriate action.

- Costs in the energy system are estimated at € 152 billion in 2020 (2005 prices) of which € 81 billion comes from mitigation costs in developed countries and € 71 billion comes from mitigation costs in developing countries but € 38 billion of these costs are compensated through trade in the carbon market.

- In practice this means significant shifts in investment flows, with some sectors/technologies receiving much higher investments compared to baseline (e.g. energy efficiency) and some much lower (e.g. primary energy production)

See Annex 17 of this Staff Working Document (Part 2) for more information on the institutional architecture needed to ensure that the global carbon market will develop in the coming decade.

6.6. Actions necessary in the forestry sector and agriculture sector to reduce emissions and associated costs

6.6.1. Actions for REDD, estimating costs

The emissions from deforestation are assessed using the G4M and GLOBIOM models. Modelling the full forest sector poses significant difficulties because of the complex interactions involved and lack of coherent data sources. This analysis gives an indication of the magnitude of impacts and the efforts needed to achieve emission reductions from deforestation and afforestation. Important to note is that the GLOBIOM model's baseline projects agricultural services including bio-energy production and thus takes the bio-energy requirements needed in the POLES baseline fully into account.

These models project in the baseline, emissions from gross deforestation (without afforestation) to amount around 4.3 Gigatons CO_2 on average for the period 2000-2010 and they decrease to around 3.5 Gigatons CO_2 by 2020. In 2020, this reflects an annual loss of 11 million hectares of forest, decreasing from a higher average annual level of around 14 million hectares in 2005. This is similar to the historical data of FAO that report that the gross deforestation rate in tropical regions was between 11.8 -13 million ha per year in the period 2000-2005[52].

FAO reported that forest expansion was on average 5.8 million hectares a year over the period 2000-2005. In the baseline, afforestation is increasing up to 2020 to roughly 7 million hectares or more than half the loss in millions of hectares from gross deforestation. A key driver for afforestation in the projected baseline is the demand for biomass for energy (as

[52] JRC estimate based on FAO data (FAO, 2006)

projected in the POLES baseline). But the impact of afforestation on overall net emissions from deforestation (emission net deforestation = emissions gross deforestation – sinks from afforestation) is substantially less pronounced. By 2020, emissions from net deforestation are only 10% lower than those from gross deforestation. This clearly underlines that reducing deforestation is a more effective and necessary policy in the short run to reduce net GHG emissions per hectare of land use than afforestation[53].

Table 17 GHG emissions/removals from land-use change involving forests in baseline[54]

Baseline emissions (million ton CO_2)	2010	2020	2030
Deforestation	3980	3517	3341
Afforestation	-103	-375	-952
Net deforestation	3878	3142	2389

Source: G4M and GLOBIOM, IIASA

Table 18 Deforestation and afforestation in baseline

Annual change in land use (million of hectares)	2010	2020	2030
Gross deforestation	13.1	10.9	9.6
Afforestation	-6.5	-7.1	-10.2
Net deforestation	6.6	3.8	-0.6

Source: G4M and GLOBIOM, IIASA

The GLOBIOM and G4M models were then used to assess the impacts of the objective of the Communication Commission "Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss"[55], i.e. to halt global forest cover loss by 2030 at the latest and to reduce gross tropical deforestation by at least 50 % by 2020 compared to current levels.

Two policy scenarios were modelled that could deliver these changes in forestry sector:

1. Increased demand for sustainable biomass for energy in order to reduce GHG emissions in the energy sector. Increased demand was projected with the POLES model for the global emission reduction scenario as presented in chapter 6.5.1. This will increase land use for sustainably managed forest plantations.

2. Specific policies introduced to reduce the amount of gross deforestation.

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53 Reducing emissions from deforestation offers significant results in the short-term, as large amounts of carbon dioxide – around 350-900 tonnes of CO2 per hectare – are not released into the atmosphere. With afforestation and reforestation this takes many years to accumulate and depending on the type of afforestation and reforestation might well not reach this level of carbon content since natural tropical forests store much more carbon than new planted forests.

54 Afforestation represents afforestation in the G4M model and GLOBIOM model. The GLOBIOM model ensures that sufficient biomass is produced to fulfil the biomass requirements in the POLES baselines.

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The G4M model is used to project impact on deforestation of specific policies to reduce deforestation. Two policy options were assessed:

(i) carbon tax and

(ii) compensation of foregone rents.

In the case of the carbon tax, land users need to pay a tax per ton of CO_2 emitted from deforestation. In case of a rent, land users are compensated for the foregone rent by not cutting the forests on their plot of land.

The Globiom model is used to assess the implications on land use stemming from increased demand for biomass for energy production. Both models are run simultaneously to assess if sufficient land is available for agricultural production and to assess what the impact could be on agricultural production, food prices and food supply.

Table 19 and Table 20 present the impacts of a tax on deforestation. At a tax level of US$ 2.3 per ton CO2 gross deforestation is halved by 2020 compared to 2005. The projected results would be increasing demand for bio-energy that will lead to increased afforestation in 2020, typically through short rotation plantations. These plantations increase the amount of afforestation to a level that is more than twice the amount of afforestation in the baseline. In 2020, total forested surface would increase substantially but in total net emissions from deforestation would still be substantial, i.e. around 1.6 Gigatons CO2 per year. By 2030, with a tax of US$ 27 per ton CO2, net deforestation emissions would go down. Gross deforestation would decrease to one tenth of the levels of the period 2000-2010 by 2030 and afforestation increase substantially leading overall to a net positive sink[56].

Table 19 GHG emissions/removals from land-use change involving forests in baseline

Appropriate global action scenario (million ton CO_2)	2010	2020	2030
Deforestation	3980	2205	447
Afforestation	-159	-630	-1124
Net deforestation	3821	1575	-677
Tax (US$ tax per ton CO2 from deforestation)	/	2.3	27.3

Source: G4M and GLOBIOM, IIASA

Table 20 Deforestation and afforestation in baseline

Change in land use (million ha)	2010	2020	2030
Gross deforestation	13,1	7,8	3,0

56 The emission profile in Figure 14 and the projections used to estimate the impact on temperature levels, used the results from GLOBIOM+G4M for the policy scenario described in this chapter up to 2030 but for 2030 and onwards towards 2050 it was assumed that emissions go down to zero and do not revert into a sink as presented in Table 20.

Afforestation	-7,0	-18,4	-20,8
Net deforestation	6,1	-10,5	-17,8

Source: G4M and GLOBIOM, IIASA

In the appropriate global action scenario, a tax level of $ 2.3 per ton CO_2 is required to bring down gross deforestation by 50% compared to 2005 by 2020.

The G4M land use model was also used to analyse the necessary funds needed if one would like to apply a rent-based approach to decrease deforestation. As such the model compares the net present value from forests or other uses of land and it assesses what needs to be paid to land owners to compensate the foregone rent from deforesting for 5 years whereby the value is determined by the value of the total carbon stock of the land for which rent is paid per ton CO_2.

The projections find that the amount of rent in 2020 is US$ 1.4 per ton of CO_2 stock on forest land to be preserved for five years. A similar study by IIASA (Kindermann et al. 2006) finds that the amount to reduce emissions by half compared to baseline[57] is US$ 1.6 per ton of CO_2.

However, total costs will greatly depend on the assumed amount of leakage[58]:

- If no leakage occurs, it can be assumed that only forest area targeted for conversion ("frontier forests") is to be included in the scheme; it is estimated that a global target of reducing deforestation by half could be reached with a payment of US$1 billion at 2000 price levels or around € 0.9 billion in 2005 prices[59] in 2020.
- Assuming that there would only be leakage on a regional scale, payments over a larger area will increase to US$ 20.6 billion (some €18 billion in 2005 prices) per year.
- Leakage on a global scale, translating into the need to compensate for the continued conservation of all standing carbon stocks globally, would cost in the order of US$209 billion (some €184 billion in 2005 prices).

But these cost estimates could be too low. For instance the Globiom model, which is used to assess the requirement on land use from increased demands for biomass for energy production. In order to provide an incentive to increase the productivity of bio-energy plantations, a carbon tax of $ 2.3 per ton CO_2 is applied. This results in a lower number of hectares needed for bio-energy related afforestation and thus lessens the pressure on deforestation. It is at present not possible to project the translation of such a tax in Globiom into a rent based approach. Neither does the projection with the G4M quantify additional costs arising from monitoring and leakage that would further increase the costs.

In Annex 16 of this Staff Working Document (Part 2) more background is given to the Commission's point of view on action on REDD, as also presented in its Communication

57 Please note that this study is a bit more ambitious given that baseline is already decreasing compared to 2005.

58 Leakage occurs when the activity causing deforestation in one project area is shifted to a different location outside the boundaries of the project area.

59 The GDP deflator has been used to convert 2000 in 2005 prices.

"Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss" of 17/10/2008[60].

6.6.2. *Actions for REDD and their relationship with emission reductions from the energy and industrial sectors*

Emissions in baseline from deforestation are projected in Table 17 to be equal to 3.5 Gt CO_2 equivalent. Action on REDD sees these emissions reduce to 2.2 Gt CO_2 equivalent (see Table 19). This is a net reduction in 2020 equal to 1.3 Gt CO_2.

It is sometimes advocated that these reductions should generate credits that can be used to offset emissions in developed countries. If this option was chosen, then targets in the other sectors in developed countries would need to be tightened in order to ensure that total emissions on a global scale do not increase. As an example, if REDD would be allowed to be fully credited and if REDD would achieve indeed a 1.3 Gt CO_2 reduction, then the target for developed countries[61] needs to be increase from -30% compared to 1990 to -38% to ensure that the global emission target can be achieved.

If the emission reductions due to REDD would not be achieved, than emission reductions in the energy system and industries need to be significantly larger to ensure that the 2°C target can be met. A sensitivity analysis with the POLES model was made that sees emission reduction action increase up to the level needed to compensate for no REDD action at all[62]. The table below shows that estimated global reduction costs in those sectors would go up by more than €65 billion in 2020. This is around three times the estimated cost of REDD action provided that leakage could be limited to the regional scale.

Table 21 Costs to the energy system and industry if there is no action on REDD

Cost of reductions in CO2 from energy and Non CO2 emissions from industry		
	Total costs in Billion € (2005 prices)	
	If REDD objectives are met	If deforestation remains like in baseline projections
	(a)	(b)
World	152	217
Developed countries	81	121
Developing countries	71	95
EU	23	34
USA	34	50
Japan	7	10
Russia	7	12
China	30	45
Brazil	3	4
India	5	5

Source: JRC, IPTS, POLES

60 COM(2008) 645 final

61 Assumed in this example to be a -30% target for the emissions from the energy system and the industrial sectors.

62 The action is undertaken according to similar assumptions as used for chapter 6.5.1.

6.6.3. Impact REDD on agriculture

In the REDD scenario as described in chapter 6.6 total land area forested increases in 2020 by 10 million hectares instead of decreasing by 4 million. Furthermore, land that is available for agriculture will in part be used for increased bio-energy production. This has a significant impact on the available land for agricultural crops other than bio-energy. In order to satisfy increasing demand for food and other agricultural commodities because of global population growth, this would require a significant shift towards more productive agricultural practices with higher output per hectare.

The land use models G4M and Globiom were used to assess the feasibility of such a scenario and its impact on agricultural prices. It should be noted that substantial uncertainties remain in the biophysical data and the potential costs of the conversion of agricultural practices, so these results have to be treated carefully. The necessary improvements in agricultural practices need to take place in particular on several fronts, i.e. timely shifts from

1. traditional grassland based livestock production systems to more intensive ones requiring less land area, which would need important changes in the diet of the cattle, and free up land for forest-based biomass production.

2. low input and rain-fed agricultural practices towards high input and irrigated crop production systems. However, the feasibility of this option needs to be assessed in specific site-conditions according to the projected evolution of water availability.

In addition to these options, it can be recommended to improve soil management practices to increase soil fertility and to recover degraded farmland soils. This could contribute to substantially increase agricultural productivity

The results indicate that achieving the sustainable bio-energy and deforestation targets set by POLES for 2020 would only see modest price increases for agricultural products assuming that improved agricultural management were feasible and timely. Price increases for crops are projected to be potentially around 6 to 7% compared to baseline in 2020.

It should be noted that such improvements and innovations in agricultural practices would create additional benefits, not only from the point of view of climate change. They would increase productivity in this sector. They could lead to reductions of GHG emissions from livestock production but care should be taken not to offset these by increased emissions from changes in land-use (e.g. changes from pasture to arable land) and fertilisation. In order to achieve these important changes, support for increasing agricultural productivity and rural development would have to be an essential element of a comprehensive global climate change policy, for instance through intensified research and capacity building in improved agricultural practices, investment in agricultural and rural infrastructure and sometimes institutional changes, all requiring strong domestic land use policies.

6.6.4. Mitigation action to reduce Non-CO2 greenhouse gases in agriculture: nitrous oxide and methane

An assessment was also made separately with the IMAGE model what type of policies could be implemented in the agriculture sector to reduce non-CO_2 GHG emissions and to what extent this is in line with the need to increase agricultural productivity if deforestation has to be reduced and bio-energy supply increased.

Under baseline assumption, the IMAGE model projects the development of non-CO2 greenhouse gases from agriculture as a function of a corresponding activity indicator (e.g. the number of cows) and assumed development in the technology and type of activity (emission factor).

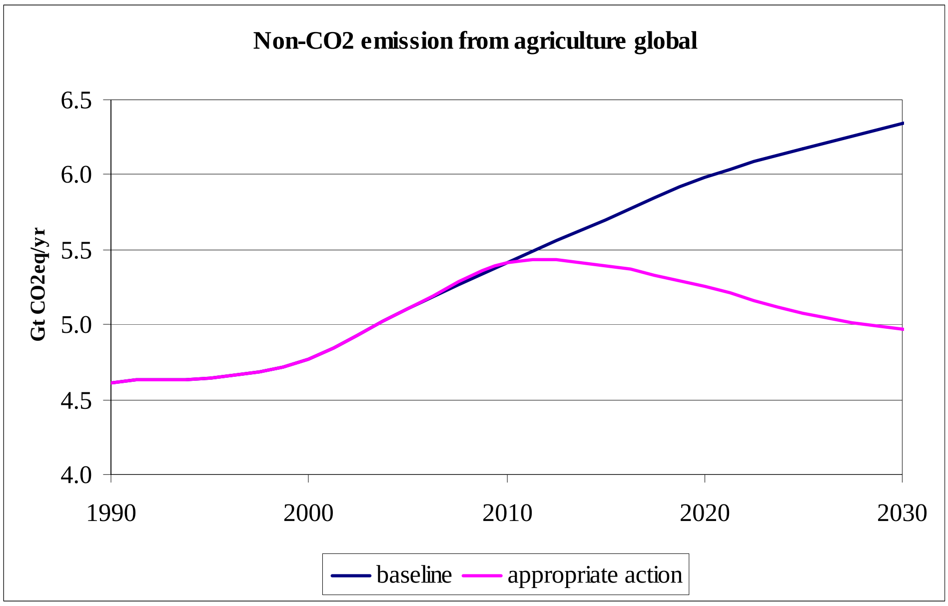
The activity indicators for the purpose of this paper are based on the baseline image projected for the ADAM project[63]. Assumptions for agricultural activities are based on the so-called Adaptive Mosaic scenario of the Millennium Ecosystem Assessment (MEA, 2005). Emission factors for the non-CO2 greenhouse gases are mostly held constant – as no climate policy is introduced. In the global action scenario, climate change policies are implemented cost efficiently, i.e. equalising marginal abatement costs for all non-CO2 greenhouse gases and all sectors in all regions. The marginal abatement costs are based on estimates published by US EPA and further work by Lucas et al. (2007).

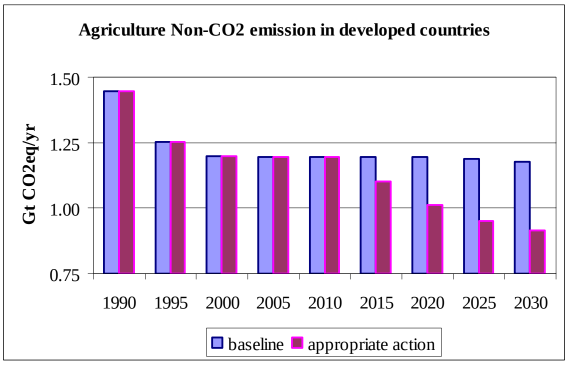
In the baseline, total CH4 and N2O emissions increase up to 2050 and slowly stabilize after this time period. The contribution in total greenhouse gases drops since their growth rate is slower than that of GHG emissions of energy and industry. By 2020 emissions from agriculture are projected to increase in the baseline to around 6 Gt $CO_{2\text{-eq.}}$, an increase of 30% compared to 1990. Growth is higher in developing countries with an increase of 51% compared to 1990 by 2020 while emissions in developed countries actually decrease over this period even though they are rather stable in the period 2005 to 2020.

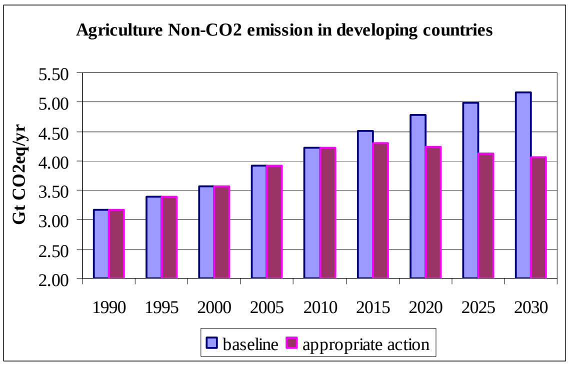
The reason why non-CO2 emissions from agriculture increase less than energy-related (CO2) emissions over the coming years is caused by the fact that most land-use related drivers of these emissions have strong saturation tendencies. For CH4, only emissions from animal husbandry are likely to increase rapidly in the absence of climate policies. Wetland rice emissions remain more or less constant, as not much expansion is assumed to occur and yields per hectare improve. Emissions from fertiliser use and animal waste are expected to lead to increasing N2O emissions.

Figure 13 Global Non-CO2 GHG emission from agriculture

[63] Adaptation and Mitigation Strategies: Supporting European climate policy, Preliminary ADAM scenarios, Project no. 018476-GOCE, http://www.adamproject.eu/







Source: IMAGE model of PBL, ADAM project

By 2020, in the global appropriate action scenario emissions from agriculture reduce on a global scale by 0.73 Gigatons $CO_{2\text{-eq.}}$ to 14% above 1990 levels compared to baseline. The total mitigation cost to deliver these reductions is estimated at US $ 8.1 billion or € 6.5 billion[64]. There are substantial cost differences between developed and developing countries. Costs in developed countries by 2020 will be around € 1.48 billion while the developing countries experience mitigation costs in the order of € 5.0 billion. This large share for developing countries is partly due to the fact that this study looked at cost efficient option, as such leading to a relatively higher share of reductions in developing countries.

The key reduction options at hand in the agriculture sector as identified in Lucas et al. (2007) and implemented in IMAGE include changing animal diets, optimising manure management and limiting grazing, reducing methane emission from rice production through water management, improving fertiliser use efficiency, restricting use of fertiliser in time and replacing current fertiliser with new types of fertiliser producing less emissions.

Some of these mitigation options are actually win-win increasing agriculture productivity and decreasing greenhouse gas emissions for a similar amount of agricultural production. As such they are the type of measures that also need to be implemented to reduce emissions from

64 1.244 US $ per Euro is assumed as average exchange rate 2005.

deforestation, while simultaneously allowing afforestation (for bio-energy purposes) to increase (see chapter 6.6). The existing barriers, often linked to uncertainties of impacts on productivity, costs and/or lack of knowledge needs to acknowledged. These implementation barriers are larger in developing countries, noting particularly Africa where in most areas such productivity increases have not happened yet. This confirms again that in order to achieve them many changes would have to take place that will require support for research and capacity building in improved agricultural practices, investment in agricultural infrastructure and sometimes institutional change, all requiring strong sustainable development policies.

Conclusions REDD & Agriculture

- It is feasible and affordable, as well as essential to reduce gross tropical deforestation by at least 50 % by 2020 compared to current levels.
- Increased demand for bio-energy will also be an important driver for afforestation and reforestation.
- But reducing emissions from deforestation is more important in the short term than increased afforestation or reforestation. Thus, the deforestation of areas for the purposes of biomass extraction for bio-energy production needs to be prevented. The recently adopted revised Fuel Quality Directive and Directive on Renewable Energy require the Commission to explore the issue of land use changes caused by an increased use of biofuels. In addition, the Commission will prepare a report and make proposals on sustainability criteria for biomass.
- If crediting of REDD actions would be allowed for offsetting purposes, then targets for developed countries need to be made much more stringent. In the above assessment they would need to be cut further to -38% compared to 1990 by 2020.
- Leakage is an important cost factor for the efficiency of REDD policies that will need to be addressed if emissions from REDD need to be reduced cost efficiently.
- Agriculture itself also offers a substantial mitigation potential in developing countries, often through intensification of the agricultural production. Such practices will need to respect local ecosystem characteristics and water, soils, biodiversity, all of which are under increasing pressure including from climate change, and all of which require protection. They could include marginal shifting from traditional grassland based livestock production systems to landless ones and limited switch from low input and rain-fed agricultural practices towards higher input and sustainable irrigation systems as well as improving soil management practices in croplands and grazing lands areas.
- This will also be crucial to compensate for pressures on food production coming from REDD and increased demand for bio-energy.
- Higher demand for agricultural land and switching to more intensified agricultural practices will see a slight increase in agricultural produce prices.
- Increasing agricultural productivity in a sustainable manner will require support for capacity building and rural development in developing countries.
- To achieve the REDD objectives through a rent based approach, an estimated € 18 billion in 2020 (2005 prices) will be necessary, if leakage can be limited to a regional scale. Not taking this action on REDD would lead to a cost increase in the energy and industry sectors of around three times the costs of action on REDD, because of additional action to be taken in these sectors.
- To reduce emissions from agriculture, € 6.5 billion of mitigation costs would occur in 2020, of which developing countries represent € 5.0 billion.

6.7. Sources of financing complementing the carbon market

The analysis in chapters 6.5 and 6.6 showed that there still remains a considerable financing gap for mitigation action in developing countries that will have to be closed to a certain extent by additional financial flows. In addition, adaptation will have to be funded as well, especially in the least developed countries.

International public financial support will have to be scaled up and mobilised. In this context, a number of key questions will have to be answered, e.g. level of funding, sources of funding, purpose of public funds, governance issues, and distribution keys.

Apart from a politically acceptable governance structure, a distribution key will have to be identified. In this respect, Table 22 analyses different options in order to determine the relative shares for the financial contribution of different countries based on:

- Actual contributions of Official Development Assistance
- Actual scale of assessment for the UN budget
- polluters pays principle, i.e. emitted GHG emissions, which could be applied only on developed countries or on a global scale
- Share of total GDP

Depending on the distribution key, the EU's contribution could range between 15 – 60 % of total funding. Again, building a composite index that reflects responsibility and capability might be the most suitable and political acceptable way forward. Furthermore, there is no doubt, that the larger the number of contributors, the higher the amounts that will be able to be mobilised, especially in view of the current economic recession.

Table 22 Possible distribution keys for countries' contributions to finance

	ODA 2007[65]	**UN budget 2006**[66]	**Poll. Pays Principle global (2005)**[67]	**GDP 2005 (Market Exch. Rate)**	**Poll. Pays Principle Annex-I (2005)**[68]
EU27	60%	37%[69]	15%	31%	28%

65 http://www.oecd.org/dataoecd/27/55/40381862.pdf Note: The data for 2007 are preliminary pending detailed final data to be published in December 2008. ODA (every one has commitment to 0.7% of their GNI) – in practice for 2007 where the total was around 104 billion USD the figures are very roughly broken down like this.

66 The Fifth Committee of the UN General Assembly decides on the scale of assessments for contributions to the Regular Budget every third year. The scale of assessments reflects a country's capacity to pay (measured by factors such as a country's national income and size of population). The figures in the table are 'assessed percentage for the year 2006' and does not necessarily reflect actual payments. http://www.unausa.org/site/pp.asp?c=fvKRI8MPJpF&b=1813833 and http://ozone.unep.org/Publications/MP_Handbook/Section_3.7_Annexes_Finance/UN_scale_of_assessments.shtml

67 Estimates from IEA 2007 C02 from fossil fuel combustion data.

68 Estimates from IEA 2007 C02 from fossil fuel combustion data.

69 http://www.europa-eu-un.org/articles/en/article_4154_en.htm

United States	21%	22%[70]	21%	28%	41%
Japan	7%	19%	4%	10%	9%
Canada	4%	3%	2%	3%	4%
Australia	2%	2%	1%	2%	3%
China		2%	19%	5%	
Mexico		2%	1%	2%	
Brazil		2%	1%	2%	
Russia		1%	6%	2%	11%
India			4%	2%	
Korea	0.6%	2%	2%	2%	

Note, PPP refers to the polluter-pays principle, according to which the share of a country is calculated on the basis of its share in global emissions calculated from C02 from fossil fuel combustion data (PPP Global) or its share in emissions of Annex-I parties only (PPP Annex I).

In this respect, the carbon market also offers new opportunities in terms of raising public revenues for such contributions in Europe. As agreed in the Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community foresees that at least 50% of the revenues generated from the auctioning of allowances should be used for climate actions[71]. As part of a financial package for Copenhagen, one option could be that Member States earmark/pledge concrete contributions for climate actions in developing countries.

6.8. Impact of the financial crisis

The financial crisis is perceived to have a real impact on the dynamics of the international climate change negotiations and on the perceptions by parties on how their baseline GHG emissions will develop and how much additional action they are willing and able to take to reduce emissions. The analysis in this assessment has included the impact of the financial crisis in its baseline, to the extent possible. Chapter 6.1 describes the baseline, and includes an explanation on how the financial crisis was taken into account. This chapter will briefly assess

70 A nation can only contribute a maximum of 22 percent to the regular budget. (The ceiling rate was lowered by the Fifth Committee in December 2000 from 25 percent to the current 22 percent and only affects the US as it is the UN's largest contributor.)

71 This concerns actions in developed and developing countries and includes for instance contributions to the Global Energy Efficiency and Renewable Energy Fund and to the Adaptation Fund,, measures to avoid deforestation and increase afforestation and reforestation in developing countries that have ratified the future international agreement, to transfer technologies and to facilitate adaptation to the adverse effects of climate change in developing these countries, and for the environmentally safe CCS, including in third countries. Under Directive 2008/101/EC, all auction revenues from aviation should be used for these purposes;

what the impact of the economic crisis could be on the total cost to reach an ambitious GHG emissions target in line with the 2°C objective.

The POLES model was used to run the "Appropriate global action scenario" as presented in chapter 6.5.1, both in case with an economic growth equal to the one assumed in baseline, which was lowered to take into account the effect of the financial crisis and in the case where this impact was not taken into account. See Annex 7 of this Staff Working Document (Part 2) for differences in assumed growth rate.

The overall result shows a decrease in costs to achieve the mitigation target by around € 20 billion. This cost reduction is by far the largest for the developed countries due to the larger impact of the financial crisis on these economies.

Table 23 Average annual cost of reductions in CO2 from energy and Non CO2 emissions from industry in 2020, for the case with and without financial crisis

	Average annual cost of reductions in CO2 from energy and Non CO2 emissions from industry in 2020, Billion € (2005 prices)	
	Not taking into account the potential impact of the financial crisis	Taking into account the potential impact of the financial crisis
World	171	152
Developed countries	94	81
Developing countries	77	71
EU	26	23
USA	40	34
Japan	8	7
Russia	9	7
China	33	30
Brazil	3	3
India	5	5

The results of the POLES model confirm the logic that lower levels GDP growth will reduce increases of energy consumption and thus greenhouse gas emissions and thus lower the costs to reduce a certain amount of emissions compared to a fixed base year.

But one should also note that a slowdown in GDP might also slow the rate at which the energy intensity of output is reduced, in particular by slowing investment in the renewal of the economy's capital stock or leading to reduced investment in innovation.

These counter balancing forces can increase costs again to reduce GHG emissions and underline the need for government policies that ensure that sufficient capital is leveraged for continued investments in low carbon technologies, also in case of an economic slowdown..

6.9. Assessment of co-benefits of climate change policies

6.9.1. Air pollution

Policies to reduce the most important GHG, i.e. CO_2, through shifting to carbon free energy sources or decreasing overall energy consumption, also tend to reduce emissions of other local air pollutants such as sulphur dioxide (SO_2) particulate matter (PM) and nitrogen oxides

(NO_x). In addition, measures to reduce methane (CH_4) and nitrous oxide (N_2O) emissions from agriculture may also have an indirect benefit for air quality. Reductions in CH_4 can reduce the formation of ground level ozone. More efficient fertilizer use can reduce both NO_x as well as N_2O emissions.

The co-benefits of reduced local air pollution due to climate change mitigation measures consist of two parts. Firstly, a positive impact on human health, materials, crops and natural ecosystems, foremost through reduced concentrations of particulate matter and ground level ozone. Secondly, a reduction of costs associated with controlling these 'local air pollutants' because lower emissions levels through climate change mitigation decrease the overall costs to reduce these local air pollutants by specific measures.

JRC has analysed the global impact of climate change mitigation measures on local air pollution. They analysed the impact of a GHG mitigation scenario. They did so by implementing it on two different options with respect to local air pollution policies:

- Option 1: Little progress is made in traditional air pollution control up to 2030.

- Option 2: Air pollution controls are tightened in the baseline on a global scale. For the EU, for instance, it is assumes that current legislation on local air pollutants up to 2020 is fully implemented. The rest of the world would follow EU legislation with one decade delay.

These two options present two extremes for future policies concerning local air pollution. For both options JRC estimated what the impact would be if the Appropriate global action scenario would be implemented.

For this assessment the global atmospheric model TM5 from JRC was used. JRC applied dose-response functions for the health impact of PM and ozone[72]. The PM impacts were capped at 100 micrograms/m3 taking into account natural emissions (e.g. sea salt and dust). The capping underestimates the full benefit i.e. in countries like China where current concentrations exceed 100 microgram in 20% of the cities. The methodology reflects the predicted age structure per country although population numbers are based on the year 2000.

The results confirm that a global GHG mitigation effort will lead to significant additional reductions in PM as well as ozone concentrations:

- Policy option 1 (stagnating air pollution policies): PM10 concentrations diminish significantly compared to baseline and life expectancy increases by around 1.7 months per person in 2030 compared to business-as-usual. Ground level ozone concentrations are reduced and life expectancy increases by an average of 0.01 months per person in 2030 compared to baseline. Under this scenario, climate mitigation measures could reduce the number of life years lost by nearly 18 million worldwide in 2030 compared to baseline. Large shares of this benefit would accrue to South Asia (including India), East Asia (including China) and the USA. Using the average value of life year lost under European

72 Pope, C. A. et al. 2002. “Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution.” Journal of the American Medical Association 287(9): 1132–41 and Worldbank/State Environmental Protection Administration P.R China (2007) Costs of pollution in China: economic estimates of physical damages, The Worldbank, Washington. D.C.

circumstances[73] suggests that the monetary benefits might range from close to € 920 billion to nearly € 2,120 billion in 2030. On top of these reductions in mortality there are positive impacts in reducing morbidity, avoiding crop damages (several billions), and ecosystems.

- Policy option 2 (improved air pollution policies): Understandably, the gains in life year lost because of additional climate change policies are lower and close to 17 million in 2030. A large share of local air pollution is already abated through specific air pollution policies in this scenario. Again significant benefits are expected in South Asia, East Asia and the USA. Total monetary benefits for this decrease in mortality range from some € 860 to around 1,990 billion per year.

Table 24 Benefits in terms of reduction in life years lost compared to baseline in 2030 without additional air pollution policies in place (scenario 1)

	Scenario 1			Scenario 2		
	life years lost (x 1000)	Valuation (€billion/yr)		life years lost (x 1000)	Valuation (€billion/yr)	
	High case	Low	High	Low case	Low	High
CANADA	51	3	6	248	1	3
USA	1013	53	122	430	22	52
CENTRAL	289	15	35	1031	5	12
SOUTH AMERICA	285	15	34	93	5	11
NORTHERN	307	16	37	100	5	12
WESTERN AFRICA	644	34	77	365	19	44
EASTERN AFRICA	199	10	24	118	6	14
SOUTHERN	102	5	12	52	3	6
OECD EUROPE	989	51	119	371	19	44
EASTERN EUROPE	343	18	41	146	8	179
FORMER USSR	670	35	80	284	15	34
MIDDLE EAST	461	24	55	254	13	31
SOUTH ASIA	6587	343	790	4620	240	554
EAST ASIA	4094	213	491	8744	455	1049
SOUTH EAST ASIA	13776	72	165	786	41	94
OCEANIA	7	0	1	2	0	0
JAPAN	223	12	271	126	7	15
World	17643	917	2117	16619	864	1994

Source: JRC (IES) – DG ENV based on the CARB and CAP scenarios

73 The values of life year lost (€52000 and €120000) were used that are typically applied for impacts assessments in the EU. There are insufficient studies in developing countries that address the 'value of life year lost' but the Worldbank/SEPA China (2007) suggest values of statistical life lost for China of 1 million RMB a factor 10 to 20 lower than typical EU values of €1-2 million.

IIASA has developed a tool that allows assessing the inter-linkages between climate change and local air pollution policies for the EU27, i.e. the GAINS model. This model was extended for specific cases under the GAINS-ASIA project[74] focussing on China and India.

They have developed for the EU, China and India a baseline scenario including existing local air pollution policies but interpreted in the least-strict way. IIASA assessed what the impact of the Global appropriate action scenario, would be on local air pollution on top of this baseline. The results indicate a reduction of emissions of local air pollutants by several percentage points in 2020 in India, China and the EU compared to baseline (see Table 25). In the EU the reduction is more significant.

In 2030, higher reductions of greenhouse gases by India and China compared to baseline result in significant reductions in the emissions of local air pollutants. The impact is more pronounced in China than in India since the CO_2 emission reduction compared to baseline is smaller for India than for China. Reductions in emission of local air pollutants are around 20 to 50 % for China and 15 to 45 % for India in 2030.

These emission reductions also imply that fewer resources are needed to control traditional air pollution. The GAINS model was used to estimate the cost, in the baseline case, to comply with existing air pollution legislation and subsequently to estimate how much this cost would be reduced if GHG mitigation policies were put in place. In 2020, local air pollution control costs are reduced by nearly €14 billion (2000 prices) in the EU27, €12 billion in China and €1 billion in India. In 2030, the cost reductions are higher: €20 billion in the EU27, €34 billion in China and around € 3 billion in India (see Table 25). The results take account of the fact that costs of air pollution control can differ between India, China and Europe due to different prices in equipment, materials and labour.

Table 25. Reduction in emissions and in air pollution control costs in India, China and the EU27 due to climate mitigation measures

	EMISSIONS (change over BAU)				Reduction Air pollution control costs
2020	CO_2	SO_2	PM2.5	NO_X	Billion €/year
EU27	-20%	-29%	-10%	-16%	13.7
China	-19%	-19%	-9%	-18%	12.4
India	-15%	-11%	-6%	-14%	1.3
2030					
EU27	-34%	-44%	-8%	-25%	20.0
China	-43%	-46%	-22%	-43%	34.5
India	-42%	-43%	-14%	-35%	3.3

Source: IIASA

74 GAINS-ASIA and GAINS-EUROPE. See: http://www.iiasa.ac.at/rains/index.html

6.9.2. *Energy supply security*

Risks to security of energy supply can be regarded as the exposure to interruption of imports or strong fluctuations in energy prices due to the fact that supply is concentrated in a few countries with high geopolitical risk. For the EU and many other developed and emerging countries as well, it concerns mainly their reliance on oil and gas.

Compared to business-as-usual, a GHG mitigation scenario reduces final energy consumption and increases the shares of renewable and other non-fossil fuels. Consequently, the consumption of oil, gas and coal decline in the policy case compared to baseline scenario. As a result the dependence on in particular oil and gas imports declines. Table 26 gives the projections for oil and gas expenditure by the EU, China, India and the US in case of the baseline and the Global appropriate action scenario. In 2020, expenditures on consumption of oil are reduced by between 16 % (China) to 27% (EU27) compared to baseline.

In 2020, the changes in gas consumption expenditures are more modest and range from +1% (China) to minus 27% (EU27). It should be noted that this takes into account that reductions in consumption will in turn reduce prices of oil and gas compared to baseline.

Both the USA and the EU27 would consume less oil in 2020 and 2030 than in the year 2005 and would decrease their dependence on oil. In China and India oil consumption would still be higher than in 2005 but the increase would be significantly smaller in the GHG mitigation scenario.

Table 26 Oil and gas consumption expenditures

		2020			2030		
		Baseline	GHG Appropriate global action scenario	%	Baseline	GHG Appropriate global action scenario	%
		billion US$	billion US$	%	billion US$	billion US$	%
China	Oil	347	292	-16%	512	373	-27%
	Gas	55	55	1%	89	76	-15%
EU27	Oil	371	272	-27%	450	265	-41%
	Gas	133	110	-17%	178	129	-28%
India	Oil	115	90	-22%	178	122	-32%
	Gas	13	13	-3%	28	26	-7%
USA	Oil	502	387	-23%	591	387	-34%
	Gas	105	99	-5%	132	108	-19%
Source: POLES ($ 2005 prices)							

6.10. Can the specific and operational objectives set by the EU meet the requirement to limit temperature increase to 2°C

GHG emissions need to have peaked globally by 2020 to have a 50% chance to limit temperature increase to 2°C[75]. By 2030, emissions (excluding reduced deforestation emissions) need to further reduce to around 10% above 1990 levels and continue to decrease rapidly up to 50%, or more to have a chance beyond 50% to meet the 2°C limit.

[75] Corresponding to an emission pathways of 450 CO_2-eq ppmv. Michel den Elzen et al. 2008

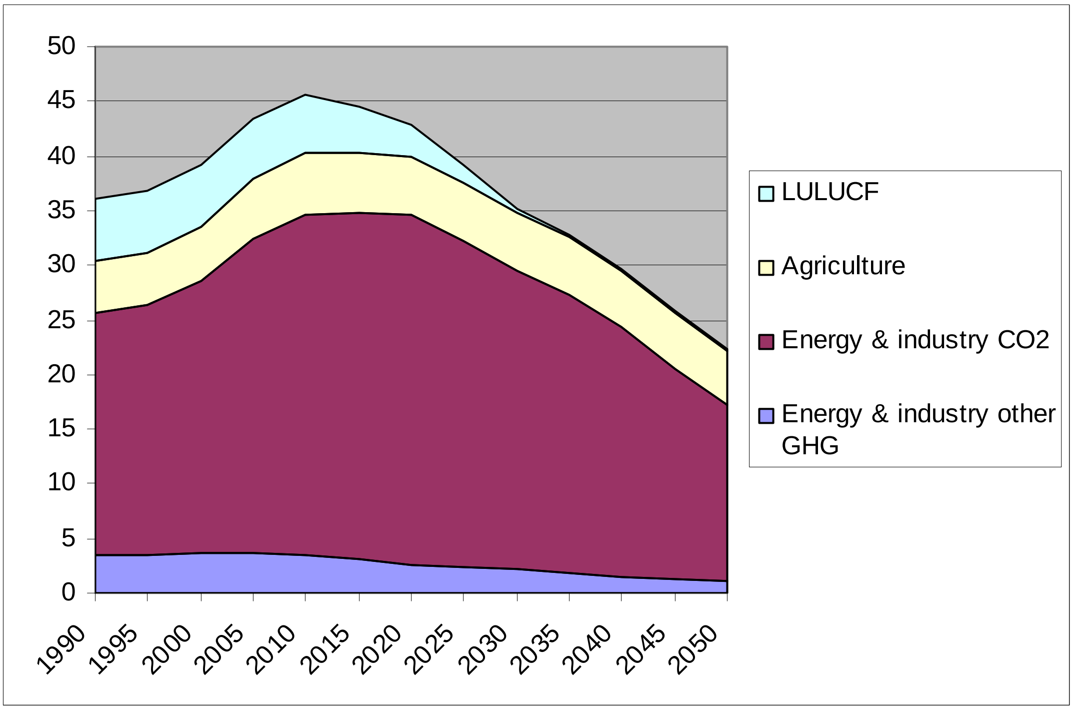
Figure 14 represents the global emission pathway if actions are undertaken as described in chapter 6.5.1 in the energy system and industries, 6.6 on REDD and in the agricultural sector. Emissions including those from deforestation peak before 2020. Emissions, excluding deforestation, level off around 2020 at around 32% above 1990 levels.

In developed countries, emissions from energy, industry and agriculture reduce by 23% in 2020 compared to 1990. To achieve the 30% target for developed countries, an equivalent of 7% of 1990 emissions would need to be acquired through offsetting mechanisms.

Emissions in developing countries from energy, industry and agriculture decrease with 18% compared to baseline in 2020. Taking into account the fact that developed countries need to offset 7% of their 1990 emissions, developing countries will need to limit the growth of their emissions to 14% below baseline by their own appropriate actions and the remainder of the reductions (up to 18% reduction compared to baseline) can be credited and transferred to developed countries.

Taking into account also the reduction from deforestation, emission growth will be limited to 20% below baseline in developing countries in 2020. Taking into account the reductions through offsetting mechanisms used by developed countries, the own appropriate actions by developing countries, including on REDD, is equal to a reduction of 16% compared to baseline by 2020.

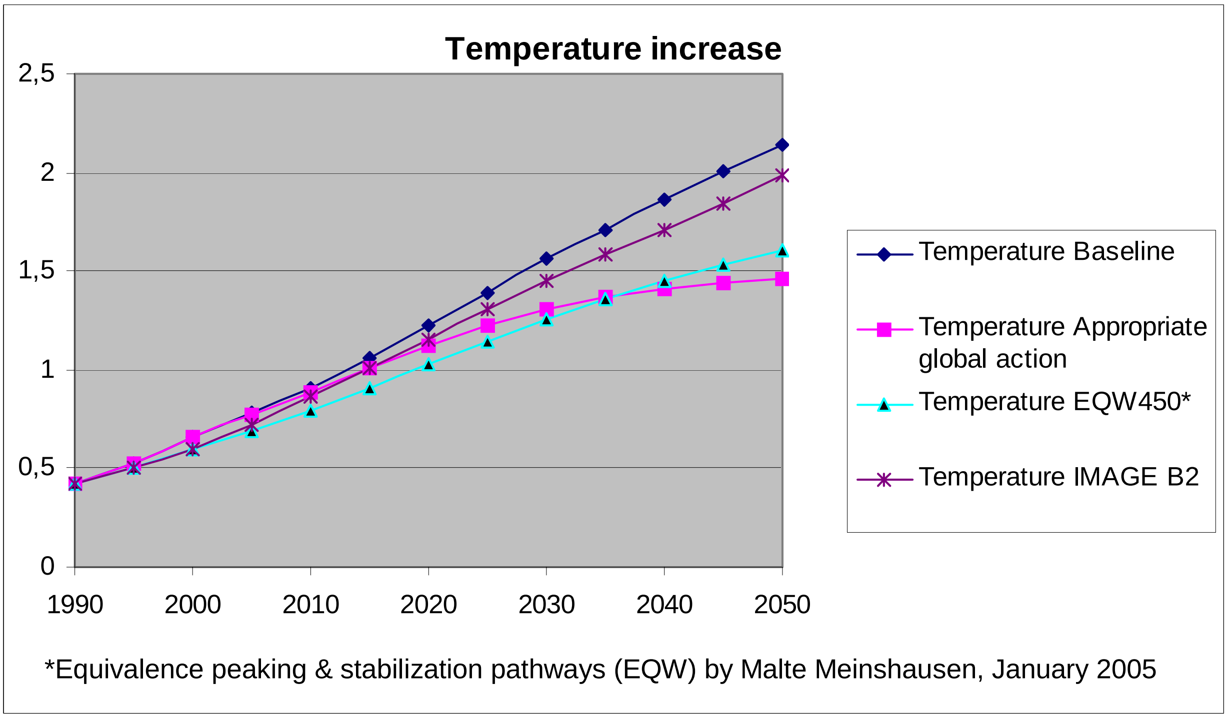
Figure 14 Emissions for all sectors in the appropriate global action scenario



Source: POLES (JRC, IPTS), G4M (IIASA), Image (PBL)

The MAGICC model was used to estimate the temperature increase up to 2050 with an emission profile as presented in the figure above. The best estimate temperature increase by 2050 stays limited to 1.5°C compared to pre-industrial levels instead of 2°C for the baseline scenario[76]. Global average temperature increases further after 2050 but with continued emission abatement it will be able to be contained within the limit of 2°C above pre-industrial levels.

Figure 15 Global temperature increase for different emission profiles up to 2050



Source: Best estimate temperature increase MAGICC model

76 The best estimate temperature projection was done using the MAGICC model, version 5.3

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