COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 23.1.2008
SEC(2008) 85

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Document accompanying the

Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020

Proposals for

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Directive 2003/87/EC so as to improve and extend the EU greenhouse gas emission allowance trading system

DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the promotion of use of renewable energy sources

{COM(2008) 16}
{COM(2008) 17}
{COM(2008) 19}

COMMISSION STAFF WORKING DOCUMENT

Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020

1. INTRODUCTION

In the opening months of 2007, the European Union stepped up its energy and climate change ambitions to new levels. The Commission put forward an integrated package of proposals calling for a quantum leap in the EU's commitment to change"[1]. A political consensus grew up in support of this approach, with the support of the European Parliament[2] and the Member States at the 2007 European Spring Council. This culminated in agreement on the principles of a new approach and an invitation to the Commission to come forward with concrete proposals, including how efforts could be shared among Member States to achieve these targets:

- an independent EU commitment to achieve at least a 20% reduction of greenhouse gases by 2020 compared to 1990 levels and an objective for a 30% reduction by 2020 subject to the conclusion of a comprehensive international climate change agreement;
- a mandatory EU target of 20% renewable energy by 2020 including a 10 % biofuels target.

This impact assessment accompanies three key policy proposals implementing the agreed energy and climate package:

(a) a proposal for a Directive on the promotion of renewable energy,

(b) a proposal for amending the EU Emissions Trading Directive reviewing the EU emissions trading system (EU ETS),

(c) a proposal relating to the sharing of efforts to meet the Community's independent greenhouse gas reduction commitment in sectors not covered by the EU emissions trading system (such as transport, buildings, services, smaller industrial installations, agriculture and waste).

This impact assessment sets out the options explored and the analysis made to underpin the policy choices made in the proposals. The work undertaken has been central to the conclusions reached by the Commission – as this summary shows, the Commission has refined its proposals in the light of their expected impacts. The ensuing proposals are complex, with mutually-reinforcing policy goals designed to dovetail to in order to achieve

---

1 An Energy policy for Europe - COM(2007) 1 - and Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond - COM(2007) 2.

2 European Parliament resolution on climate change adopted on 14 February 2007 (P6_TA(2007)0038).

the EU's goals in a politically acceptable as well as an economically efficient way. The implications of the proposals are substantial – but the option of policy design chosen gives the EU an opportunity to make adaptations to change significantly less challenging. Finally, the European Union is promoting change which will have a profound impact on Europeans for decades to come, so the Commission has taken great care to ensure that its proposals can be demonstrated to be the fruit of careful analysis by policymakers.

The work on this analysis started well before the Commission's proposals of January 2007. As the work has deepened, certain cost assumptions set out in those proposals have changed. One reason is that over the last twelve months, there have been substantial changes in energy prices, both in relative and absolute terms, for both conventional and renewable energy sources.

2. KEY PRINCIPLES FOR IMPLEMENTATION

The Commission has based this impact assessment on a number of key principles:

Cost-effectiveness - achieving the agreed objectives can have significant economic impacts and therefore the implementation of cost-effective policy instruments is crucial.

Flexibility – The impact assessment takes into account different ex-ante national circumstances, e.g. projected GDP growth, changes in industry and energy sectors. However, these projections are uncertain. Therefore the proposed policy instruments need to allow for sufficient flexibility in the manner that the targets are achieved. Without policy instruments that allow for flexibility, any variation from ex ante projections could lead to costs which a less rigid option could avoid.

Internal market and fair competition – The proposed policy instruments need to be consistent and create a level playing field in the EU that ensures fair competition among EU industries in the context of the internal market. This can be achieved through the use of market based instruments such as the EU-ETS and other community wide policies and measures such as product standards.

Subsidiarity – It is important to ensure that action is taken at the most appropriate level. In some sectors, such as transport, Members States hold key competences to define policies and measures such as ambitious taxation schemes, traffic management, modal shift, public transport, urban and transport planning. In these sectors, the EU needs to create the enabling framework, concentrating for instance on setting minimum targets, product standards and other supportive policies. In other areas, where there is a single market with free competition, having 27 national rules, standards and regulations would unnecessarily raise costs and distort economic decisions. For these areas it is appropriate to provide a detailed regulatory framework at the European level.

Fairness – The European Council in March 2007 recognised that it is necessary to take into account Member States' different circumstances and the reality that differing levels of prosperity have an impact on Member States' capacity to invest.

Competitiveness and innovation – Until a comprehensive international agreement is reached, carbon leakage could occur undermining the overall environmental objective of EU climate and energy policies. In such circumstances, some energy-intensive industries particularly exposed to international competition could be affected. The need to protect the competitive position of EU industry has been taken into account in the design of the proposals while, at the same time, the agreed objectives reflect a clear commitment to take leadership on climate change, to improve energy security and accelerate innovation and create a competitive edge in clean energy and industrial technologies.

3. METHODOLOGY

The climate and renewable energy targets are ambitious in nature and will require a significant initial economic investment, even if the overall long term benefits are positive and important for the sustainable development of the EU economy. This underlines the importance of the question on how to put in place policies which minimise economic costs and at the same time distribute the effort in a fair manner amongst Member States and across different economic sectors.

(a) Economic modelling tools

For the purpose of this impact assessment, a set of modelling tools has been used. No single model is able to assess the full range of parameters and impacts of three different policy proposals at different levels (EU as a whole, Member States' level, sectoral level) – and the complexity of the package would in any event call for the options to be explored in a variety of ways, with different models used to test out the robustness of the options.

The impacts of different methodologies to share the efforts for the three policy proposals have therefore been assessed through a number of models and options.

In this context, it is important to underline that modelling tools have not been used for determining targets, but for assessing the effects of different allocation methodologies and policy design choices. Annex I contains a description of the main models used.

(b) The GHG reduction effort: the need to determine national targets for GHG reductions not covered by the ETS

The EU ETS is a policy instrument to reduce greenhouse gas emissions in electricity plants and major industrial installations. It covers today some 40% of all EU-27 greenhouse gas emissions. The impact assessment for the EU ETS review assesses several options with respect to the cap-setting procedure under the EU ETS. The preferred option that comes forward is a single EU wide cap for the emissions covered by the EU ETS, ensuring as such effectiveness and a level playing field in the single European market in setting the appropriate cap, better predictability, simplicity and transparency, guaranteeing international credibility, and ensuring to achieve the appropriate contribution of the EU ETS to the 20% GHG reduction commitment.

The choice of one EU-wide cap under the EU ETS implies that the total effort for greenhouse gas reduction must be divided between the EU ETS and non EU ETS sectors. A second consequence is that the sharing of greenhouse gas reduction efforts among Member States is determined solely for sectors not covered by the EU ETS. These sectors represent today some 60% of total GHG emissions in the EU and relate to a wide range of sectors covering mostly small scale emitters, such as transport (cars, trucks), buildings (in particular heating), services, smaller industrial installations, agriculture and waste[3]. In these sectors, Member States hold key competences to define and implement policies and measures. At the same time, a number of EU-wide measures for instance related to energy efficiency standards, the Common Agricultural Policy or waste legislation contribute to emission reductions in these sectors.

(c) Base year

In the impact assessment, the year 2005 has been used as the base year or 'yardstick' against which greenhouse gas reductions and increases in renewable energy shares are presented. Calculating reductions and renewable energy shares with 2005 gives a transparent and easily understandable picture of the changes needed, as it compares such changes with the present situation.

In addition, 2005 is the only year for which reliable verified emission data are available for both the EU ETS (verified emissions at installation level) and the overall GHG emissions of Member States as reported to the UNFCCC[4]. For the distribution of the overall GHG reduction target between the EU ETS and sectors not covered by the EU ETS, consistent use of both data sets is necessary to ensure that their combined effect adds up to the 20% overall GHG reduction compared to 1990.

(d) Unit of measurement for energy

Energy is often expressed in terms of "primary energy consumption". This method measures the energy content of the first commodity or raw material which is the basis for multiple energy uses before transformation into final energy use. As such, no transformation losses are taken into account. For instance, for electricity that is generated through wind, hydropower or solar energy it is assumed that the primary energy input is equal to the energy output. This puts these 'non-thermal' renewable energy sources at a disadvantage against the other energy sources because even if they would produce the same amount of electricity, they still would require a lower amount of primary energy as no transformation losses are accounted for.

This bias against renewable energy becomes increasingly significant as the share of these renewable energy sources grows within the overall energy mix. Another method that measures "gross final energy consumption", defined as the energy commodities delivered to final consumers for energy purposes, neutralises this problem. Existing European legislation (Directives 2001/77/EC and 2003/30/EC) has set renewable energy objectives (in the electricity and biofuels sectors) more on the basis of final energy consumption than of primary energy consumption.

For these reasons, the Commission has adopted final energy consumption as the unit of measurement of renewable energy targets.

---

3 Agriculture and waste lead to substantial amount of non CO2 greenhouse gas emissions (methane, N20). All non CO2 greenhouse gas emissions represent some 20% of total greenhouse gas emissions in the EU, CO2 represents some 80%.

4 Malta and Cyprus have no reduction commitment under the Kyoto Protocol and thus no annual emission reporting requirement under the UNFCCC. But under the EU Monitoring Mechanism Decision No 280/2004/EC an annual inventory report has to be compiled by all Member States.

(e) Assessing the options

To implement both the renewables target and the GHG reduction commitment, a wide range of policy design choices will have to be taken. For the purpose of assessing the overall impacts of these different choices, several modelling options using the set of models have been developed, reflecting combinations of policy design choices. However, all options are based on the simultaneous achievement of both the 20% renewable target and the 20% reduction of greenhouse gas emissions.

The central point of the impact assessment was an option centred on cost-efficiency at the EU level. This option reflects a least cost approach against which both targets could be reached simultaneously within the EU at least cost for the EU as a whole, under a set of framework conditions such as no exogenous strengthening of energy efficiency improvements or no import of JI/CDM credits. It therefore assumes that marginal costs across all Member States and all sectors are equalised, both for greenhouse gas emission reductions within and outside of the EU ETS as well as for the deployment of renewable energy. This assessment demonstrates that a purely cost efficient allocation of the effort to Member States would lead to substantial differences in the economic costs between Member States. Since the Commission considers that this outcome would represent a disproportionate call on Member States with the lowest levels of GDP per capita, it examined alternatives.

Several options have been analysed against the core cost-efficient reference option, with a view of reaching a fair distribution of effort between Member States without incurring a significant increase in the overall economic cost. These policy design choices relate to the targets set for GHG reductions in the sectors not covered by the EU-ETS, the renewables targets and the amount Member States are allowed to auction under the EU ETS.

The impact assessment of the renewables target also assumed the implementation of yet unimplemented energy efficiency policies, such as those stipulated in the Energy Efficiency Action Plan. These were not specifically included in the cost efficient reference option which is only driven by carbon prices and renewables energy incentive policies.

Additionally the impact of access to credits from project based activities such as CDM on the costs of achieving the targets was assessed.

Finally, in order to address concerns of carbon leakage and of the competitiveness of internationally exposed energy intensive industries, some options have been assessed to find optimal ways for limiting the potential negative impacts through (i) different levels of access to project based activities such as CDM, (ii) the use of international sectoral agreements, (iii) the continued free allocation of allowances to industrial installations other than the power sector, and (iv) the inclusion of imports of energy-intensive goods in the EU ETS.

All policy scenarios take into account gradual technical efficiency improvements, normal capital stock turn over (e.g. old power plants being replaced by more efficient new ones), effects of the relatively higher projected energy prices (using an assumption of US$ 61 per barrel of oil), energy efficiency policies implemented in the Member States up to the end of 2006 and additional efficiency effects of higher carbon prices.

4. THE COST-EFFICIENT REFERENCE OPTION

(a) Overall results

The cost efficient reference option reaches both the 20% GHG reduction target and the 20% renewable energy target simultaneously at a direct economic cost[5] of 0.58% of EU GDP or € 91bn in 2020. These objectives are projected to be reached at a carbon price of € 39 per tonne of CO_2 and at a renewable energy incentive of €45 per MWh. Oil and gas imports are expected to go down by some € 50bn in 2020, air pollution control costs drop by around €10bn in 2020 (see table III, column 1 for more details) while electricity prices are likely to go up by 10-15% in comparison to today's level (see chapter 10). Overall, this leads to an energy intensity improvement of approximately 32% between 2005 and 2020[6].

The cost efficient reference option assumes no access to emission reduction credits from projects in third countries such as CDM. If this would be allowed, as in the current proposal, costs are estimated to decrease to 0.45 % of GDP (see Chapter 8 and Table III, column 3).

(b) High oil price cost efficient scenario

The cost efficient reference option assumes that oil prices rise from US$ 55 per barrel in 2005 to US$ 61 per barrel in 2020. A high oil price baseline scenario was also assessed that projects oil prices to increase further to US$ 100 per barrel in 2020 with related price increases for natural gas and coal. Total energy system costs increase substantially in the high oil price scenario, with € 275 bn.

On the other hand the additional effort necessary to achieve the GHG and RES targets decreases with around € 32 bn to € 59 bn or just below 0.4% of GDP, demonstrating that the cost of implementing the GHG and RES targets is much lower than the economic impacts of current oil price increases.

(c) Relative efforts for the EU ETS and non ETS sectors

To determine the effort to achieve the 20% greenhouse gas reduction commitment between the EU ETS, i.e. the EU ETS cap, and the sectors not covered by the ETS, the preferred choice has been to use the cost-efficient reference option as a basis, ensuring minimal overall cost. The resulting carbon price in this scenario is €39 per tonne of CO_2.

The projected cost effective distribution of effort to meet both GHG and RES targets leads to the following sharing of the effort between the EU ETS and Non-ETS sectors[7]:

---

5 Direct economic costs are the increased costs experienced in the energy system (investment costs and changes in operating, management and fuel costs.) and due to mitigation measures for the non-CO_2 gases. They do not represent a net loss in GDP. They give an assessment on the amount of additional resources within our GDP that need to be directed towards mitigation measures and renewable energy to achieve the GHG reduction and renewables targets.

6 This is a considerable acceleration of energy intensity improvements compared to past trends in the last 15 years (between 1990 and 2005 energy intensity improved by 19%).

7 Note that the overall required GHG reduction effort in the EU compared to 2005 is less than 20% to achieve a reduction of 20% compared to 1990 given that the EU's GHG emissions, including aviation, in 2005 are already around 6.8% below the 1990 level.

- The EU-wide cap for current ETS sectors would need to be reduced by approximately 21% compared to 2005[8] by 2020.

- The sectors not covered by the EU ETS would need to reduce emissions by around 10% compared to 2005.

This division, with about 60% of reductions to be achieved in EU ETS sectors, reflects the larger cost-effective potential in particular in the electricity sector compared to non ETS sectors. In addition, it is estimated that more than half of the 20% renewable energy target is achieved in the EU ETS sectors, as such increasing the cost efficient GHG reduction effort within the EU ETS and demonstrating the synergies between the EU ETS and renewable policies. It also underlines that there is a need for the possibility of flexibility in achieving the renewables targets because they could have a significant impact on the reduction options in the EU ETS where full flexibility is built into this approach.

It should be noted that within the non ETS sectors, there are also considerable differences, with larger reductions in non CO2 gases (-21% compared to 2005), and lower CO2 emissions reduction opportunities from for instance buildings, and even more so in transport (-7% compared to 2005).

(d) *Distributional* effects in the cost-efficient reference option

The differences in increased direct energy system costs and non CO_2 mitigation costs in 2020 relative to GDP are substantial between Member States. In Table II, Scenario 1 the increased direct costs relative to GDP are given for the cost-efficient reference scenario for each Member State. On average, these increased direct costs amount to 0.58% of the EU GDP. However, the country specific results show that a cost-effective distribution of the effort among Member States results in proportionally higher direct costs for Member States with lower GDP per capita and hence the smallest capacity to invest in GHG mitigation and renewable energy. The impact assessment further shows that also in terms of macro-economic GDP effects a similar conclusion arises relating to the cost-effective distribution of effort.

The large national differences in these costs are not consistent with the need to share the effort in a fair and equitable way, as agreed by the Spring European Council. It should be emphasized that with EU enlargement economic and social divergences in the EU-27 have increased considerably, with GDP/capita in some countries by a factor of 10 lower than in the richest countries.

The design choices for the policy instruments proposed need to take these large differences in impacts into account and ensure that the distribution of efforts would lead to a fairer distribution of the impacts between Member States. Three major policy design choices as regards differentiation have been assessed:

- Targets for Member States in the sectors not covered by the EU ETS could be differentiated (see Chapter 5).

---

8 The ETS sector as a whole, including intra EU and outbound aviation, would see emissions reduce with around 18% compared to 2005. See Table 3, column 1.

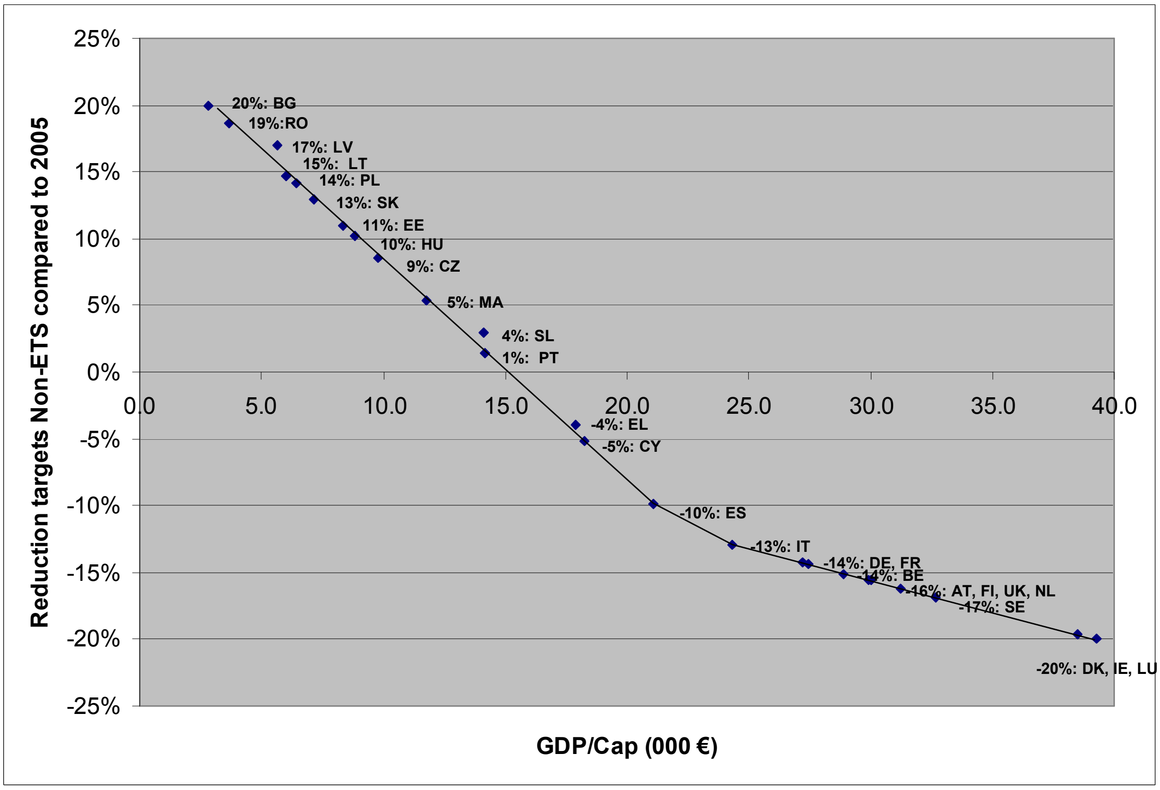
- Increased use of auctioning in the EU ETS could allow for a partial redistribution of the right to auction allowances among Member States (see Chapter 6).

- National targets set for the deployment of renewable energy could be differentiated between Member States (see Chapter 7).

5. DIFFERENTIATING BETWEEN MEMBER STATES' GREENHOUSE GAS REDUCTION EFFORTS IN NON EU ETS SECTORS

In the impact assessment, a range of options have been considered. Table I, column 2 and the Figure below represents an alternative scenario from the cost effective option whereby the targets in the sectors not covered by the EU ETS are modulated according to the relative level of GDP/capita of Member States. Member States with a GDP/capita below the EU average would need to reduce less than the EU average (i.e. around -10% below 2005 levels) and in some cases even be allowed to increase their emissions above 2005 levels in the sectors not covered by the EU ETS with a maximum of +20% above 2005 levels. Member States with a GDP/capita above the EU average would need to reduce more than the EU average with a maximum reduction of -20% below 2005 levels for those Member States with the highest GDP/capita.

Figure: Country specific targets for non EU ETS modulated on the basis of GDP/capita



In this approach, countries with a low GDP per capita would be allowed to emit more than they did in 2005 in sectors not covered by the EU ETS, thereby reflecting projections that their relatively higher economic growth will be accompanied by increased emissions in for instance the transport sector, and to a lesser extent in heating of buildings. Nevertheless these targets still represent a cap on their emissions and represent a real contribution from those Member States.

Table II, Option 2 shows the effects of these differentiated targets on the direct costs. While for the EU as a whole the overall cost only increases from 0.58 to 0.61% of GDP, cost reductions can be substantial in those countries with a very low GDP per capita relative to the EU average. Overall, the range of direct cost increases per Member State in this modulated allocation is much closer to the EU average compared to the cost-effective allocation. Thus, the modulated allocation leads to a more equal and fair effort across EU Member States.

6. A PARTIAL REDISTRIBUTION OF AUCTIONING RIGHTS UNDER THE EU ETS

The impact assessment of the EU ETS review concludes that the preferred long term option is full auctioning with free allocation taking place during a transitional period based on harmonised EU-wide rules, and taking into account progress in reaching an international agreement to avoid net carbon leakage and for those installations in energy intensive sectors exposed to international competition. This impact assessment also analysed the macro-economic and distributional effects of the introduction of high levels of auctioning.

(a) Financial revenues from auctioning

Revenues that can be generated through auctioning are substantial. If all sectors in the EU ETS would have to acquire allowances via auctioning at a carbon value of around € 40 per allowance in 2020 as estimated for the cost-efficient reference option, then auctioning revenues would represent some 0.5% of GDP, or € 75 bn in 2020. In some new Member States, revenues could even exceed 1% of GDP. It should be recalled that auctions are open to operators from all Member States.

In the case of partial auctioning (e.g. only full auctioning for the power sector), auctioning revenues would be reduced to around half of these estimates. More use of project based activities such as CDM would further reduce revenues for national authorities due to lower carbon prices.

(b) Distribution of auctioning rights to Member States

Even when taking into account the positive re-distributional effects of a GDP/capita modulation for the targets in the non EU ETS sectors, the overall relative direct costs would still be significantly high in a number of Member States with a relatively low GDP/capita compared to the richer ones. These higher relative direct costs are the result of a larger renewable energy potential as well as to large mitigation potentials in the EU ETS sectors and a relatively low GDP/capita. For this reason, it is useful to consider alternative options for the distribution of auctioning rights which, together with the target setting approach for the non EU ETS sectors, could further reinforce the criterion of fairness between Member States. Of course, as national auctions will have to be open to all installations in the EU, this would only have distributional effects at Member State level and would not affect the level playing field for the installations covered by the EU ETS.

In the impact assessment, a range of options have been considered. For the cost estimates as presented in Table II, the option is retained whereby 90% of the auctioning rights are distributed according to the Member States' share in the 2005 emissions in the EU ETS, with the remaining 10% auctioning rights distributed to low income countries taking into account their GDP/capita and their overall growth expectations. This would result in new Member States auctioning more allowances than their domestic sectors need to acquire. Table II, option 3 shows the same energy system costs as in option 2, increased by the amount each Member States' ETS sectors need to spend to acquire allowances and decreased with the amount of auctioning revenue received by the Member States. Such a distribution method of auctioning rights can result in a significant reduction of the overall direct costs experienced by Member States with a relatively low GDP/capita. At the same time, for the richer countries the overall increase in direct costs remains limited. The impact assessment also shows that in terms of macro-economic effects (GDP, private consumption, employment), such a redistribution can have positive effects for low income countries.

(c) Macro-economic effects of auctioning

The effects of the package in general and of auctioning in particular on GDP, private consumption and employment have been assessed with the GEM-E3 and PACE models under various modelling scenarios In these scenarios, it has been assumed that auctioning revenues are recycled back into the economy. In the case of free allocation, it is estimated that GDP would be reduced by a little more than -0.5% by 2020, or in other words, GDP would increase between 2005 and 2020 by 37.5% instead of the projected 38% (see table III). The introduction of auctioning in the EU ETS reduces negative GDP effects: from -0.5 to -0.35%. Such effects are, however, not confirmed in the simulations with the PACE model, where there are essentially no macroeconomic differences between free allocation on the one hand and auctioning combined with revenue recycling on the other. The economic literature shows that the macro-economic impact of auctioning largely depends on how revenues are recycled back to the economy.

The primary difference between auctioning and free allocation of allowances is in terms of their impacts on income distribution. Under auctioning the allowance revenues go to the public authorities, whereas with free allocation the value of the allowances goes to the installations covered under the ETS. The opportunity cost of an allowance is identical in both cases. The adverse macroeconomic impacts of introducing a greenhouse gas emissions constraint through auctioning in the EU ETS sectors can be partly offset by returning the allowance revenues to the economy. Obviously, the method chosen by Member States to recycle these revenues in the economy is important to determine the scale of this offsetting effect. Direct transfers to households improve private consumption, but could have less impact on employment. Reduction of labour taxes could generate benefits for employment and reducing corporate taxes could decrease the direct impact on the sectors affected.

Full auctioning of allowances imposes an additional financial cost on firms, in particular energy-intensive ones if these are unable to pass through the cost of allowances due to exposure to intense competition from outside the EU (see Chapter 11).

7. RENEWABLE ENERGY

(a) Renewables energy targets

As with GHG targets, setting renewable energy targets based on the cost efficient reference option results in an uneven allocation of effort and costs amongst Member States. Thus, a complementary option for spreading economic efforts more evenly between Member States compared to the reference option was used.

The impact assessment provides an analysis of two main options for the distribution of the effort in renewable energy:

1. on the basis of Member States' national renewable energy resources potential

2. on the basis of requiring half of the effort to be made through a flat-rate increase in the share of renewable energy and the other half weighted by GDP, modulated to take account of national starting points and efforts already made.

Both options have been assessed against a number of criteria. It has been concluded that the combination flat rate/GDP is more appropriate and better respects the criterion of fairness.

(b) Improved Guarantee of Origin System

A guarantee of origin (GO) regime was created by Directive 2001/77/EC in order to facilitate domestic or international trade in renewable electricity (i.e. proof of the green nature of the electricity) and to increase transparency in consumers' choice between renewable and non-renewable electricity. The Directive established certain minimum requirements, however their use is voluntary. Currently, some Member States use them for disclosure purposes; others simply recommend such practices; others still use them to qualify for national support schemes. These differing national perspectives have lead to different specifications for GOs in Member States, unnecessarily increasing transaction costs.

The impact assessment analyses the standardisation of the information requirements on the guarantee of origin, extending the regime from the electricity to the large scale heating sector, requiring mutual recognition and setting guidelines on issuance. The result of such standardisation should be the creation of a unique and robust certification regime which is accurate, reliable and fraud resistant. The analysis suggests that such a regime will greatly facilitate trade in renewable energy and help Member States develop their renewable energy resources in the most cost effective manner possible.

(c) Transferability of Guarantees of origin of renewable energy

A consequence of the approach chosen for determining renewable targets, is that targets will be more difficult to achieve for those countries that have a lower resource potential and a relatively higher target. The introduction of transferable Guarantees of Origin (GO) for renewable electricity and large scale heat is foreseen in order to enable Member States to meet targets more cheaply and therefore more easily.

The benefits through reduced direct costs due to improved flexibility compared to a situation where each country has to meet its target domestically has been analysed with the PRIMES model, and have been estimated at some € 8 bn in 2020. A different modelling exercise using the PACE model on a different basis (the GHG target plus a 30% target for renewables electricity) estimated that with no flexibility, the deterioration in EU economic performance could represent 0.2% of GDP. It also pointed to a significantly stronger increase in electricity prices than other models. The differences between estimates of the impact of GO trade are due to differences in estimated costs and cost effective potential in renewables, differences in assumed energy efficiency gains (which lead to a lower absolute level of renewables to meet the 20%), and the fact that some of the models include imports and exports of renewable energy which are independent of GO transfers whilst others do not.

Whilst the broad, macroeconomic advantages of opening the GO market are clear, the uncertainty surrounding the distributional impacts and the risk associated with changes to support schemes imply that a cautious approach is appropriate. Uncertainty and risk are difficult issues to model and analyse, but it is clear that industry growth that is dependant on support (such as most of the renewable energy sector today) is sensitive to any change in support regimes. In addition the impact assessment finds that unrestricted GO trade could have an impact on innovative technology promotion measures and could create some significant windfall profits for existing producers of renewable energy. Finally, the prospect of buying GOs could reduce pressure on national governments to remove barriers to large scale renewable energy development (grid access design, congestion management, balancing markets, planning regimes and administrative processes) which could put the achievement of the national targets at risk.

The extent to which Member States will rely on such flexibility arrangements will depend on a range of factors that are difficult to predict ex ante. Overall, allowing for flexibility around flat rate/GDP approach targets allows for cost reductions and provides additional incentives for RES in countries with a high potential but lack the capability to finance the necessary investments. As such, the transfer of Guarantees of Origin could lead to a net financial transfer towards countries with a lower target (low income countries) and a relatively high renewable potential. Table II, option 5 shows the direct costs in each country, taking into account financial flows due to the transferability of GOs[9].

In conclusion, the Commission's preferred option is to create the regime enabling the transfer of GOs and to leave sufficient discretion to Member States in terms of the level and pace of their transferability. This would permit Member States to continue to manage their support schemes in view of fostering renewable energy technology development within their national territory. At the same time there would be a partial market opening that allows Member States to take advantage of cheaper resources and achieve their targets in a more cost effective manner.

An assessment of the transfer of guarantees of origin between Member States in circumstances where Member States retain the option of national support schemes should be undertaken after sufficient experience has been gained.

(d) Biofuels

The European Council decided on a 10% biofuel target for transport, subject to production being sustainable, second-generation biofuels becoming commercially available and the Fuel Quality Directive being amended accordingly to allow for adequate levels of blending. In the renewable energy roadmap, the Commission assessed the impact of achieving this goal. It concluded that it would incur significant additional costs but result in a significant reduction of oil imports, generate extra employment and reduce greenhouse gas emissions.

In order to ensure that all the biofuels used to meet the 10% binding target are produced in a sustainable manner fulfil the sustainability criteria and contribute to CO_2 reductions, the

[9] These estimates have a higher level of uncertainty as they are very sensitive to the estimation of the cost-effective potential of renewables in each country, which is difficult to assess and project until 2020

Commission committed itself to the creation of a biofuels sustainability regime in the renewable energy roadmap.

The Commission's impact assessment analyses a number of key options for the design of the scheme and concludes that it should include a minimum level of greenhouse gas saving of 35%, a ban on the conversion of areas with a high carbon stock or a high biodiversity value and (in the EU) an extension of the cross-compliance criteria to cover all feedstock used for biofuel production.

The scheme would potentially increase annual greenhouse gas benefits by at least 7 Mt CO_{2eq}. These calculations do not take into account the greenhouse gas benefits of avoided land use change or the biodiversity benefits.

8. THE USE OF PROJECT BASED ACTIVITIES SUCH AS CDM AS PART OF THE INDEPENDENT 20% COMMITMENT

The Kyoto Protocol has created the novelty of earning carbon credits as a reward to investments in climate-friendly projects abroad. The EU has always been favourable to CDM as it reduces greenhouse gas emissions in a cost-effective way globally. Within the EU ETS it offers opportunities to businesses to use these credits for compliance against their domestic targets. Moreover, allowing for credits generated through project based activities such as CDM in the absence of an international agreement can significantly help overcome some of the possible negative economic impacts on the European industry. However, this would require a bigger effort to reach the renewable target and improvements in air pollution would be smaller. Finally, there would be less pressure to drive deployment and further development of innovative clean technologies in the EU.

(a) overall effects of investments in project based activities such as CDM

The impact assessment considers various levels of access to CDM type of mechanisms. In this context, it is important to distinguish between 2 totally different situations: (1) the case of a 20% independent GHG reduction commitment with no international agreement and (2) the case of an international agreement, and a 30% GHG reduction in the EU. In the case of a 20% independent commitment, the impact assessment assumes that the EU would be the only region in the world in demand for CDM credits.

Under a 20% GHG reduction scenario where only the EU would be in demand for CDM credits and with limitless access to such credits, carbon prices are projected to be potentially as low as of 4 €/tonne and EU emissions would be reduced only marginally. This would imply that no significant changes in our energy system would be achieved, that oil and gas savings would not materialise and that technological innovation is not spurred within the EU. In addition, the 20% RES target would become much more difficult to achieve, and significantly more support for renewable energy technologies would be required. This approach would mean less EU leadership on climate change and a smaller impetus to develop and deploy advanced energy and low carbon technologies.

Therefore other scenarios were analysed where project based activities such as CDM can still contribute to the achievement of the EU’s independent 20% GHG reduction target (see table III, column 3), but with some limitations. The Option in column 3 assumes that project based activities are allowed up to a level which would ensure that the carbon price in the EU is not higher than € 30[10].

The resulting decrease in internal reductions would be significant. In case of a carbon price of € 30 per tonne of CO_2, the overall emission reduction efforts by 2020 would reduce by a third compared to a situation without access to CDM-type mechanisms, namely from -14.5% to -9.3% compared to 2005 emissions. At the same time the renewables support needs to be increased to ensure that the RES target can be achieved. Overall costs would decrease to 0.45% of EU GDP or some € 70bn in 2020, i.e. significantly lower compared to the case with no access to CDM type of mechanisms. Equally, benefits for instance related to air quality would diminish.

(b) the effects of access to JI/CDM in the 2nd EU ETS trading period and banking

In considering the appropriate access to CDM for the period 2013-2020, it is also important to take into account the treatment of CDM credits in the 2008-2012 EU ETS trading period. The decisions on the National Allocation Plans for this period have allowed JI/CDM credits over the 2nd trading period in the EU ETS of more than 13 % on top of the total emission cap that has been set. Due to the possibility to use JI/CDM credits for compliance in the period 2008-2012 and to bank any excess allowances, the existing limit on the use of JI/CDM in the 2nd trading period of the EU ETS could have a large impact on the period after 2012. Assuming that this 13% absolute cap in the period 2008-2012 is spread out for compliance over the entire period 2008-2020, this would represent approximately 5% of the total cap, or already around a quarter of the required reduction effort by 2020 within the EU ETS.

It can therefore be concluded that the decisions taken under the national allocation plans for the 2nd EU ETS trading in relation to the allowed level of carbon credits, in combination with the possibility to bank allowances from 2008-2012 into the 3rd trading period (2013-2020) resembles option 3 in Table III.

(c) Towards the 30% greenhouse gas reduction target through more CDM credits

To assess the impact of taking on a higher reduction commitment under an international agreement of -30% GHG emissions by 2020 compared to 1990 two scenarios where assessed in the POLES model: One where the 20% GHG reduction target is achieved without access to CDM and one where the 30% GHG reduction target is achieved with full access to CDM. The projected impact on the EU energy system and thus GHG reductions is similar for both scenarios with the major difference that around one third of the effort in the 30% GHG reduction scenario is achieved through CDM credit purchases.

This indicates that high internal emission reductions under the independent commitment, close to the 20% GHG reduction target, would require only small additional changes to the EU energy system if a 30% multilateral target would be agreed and increased access to the CDM would be foreseen. Nevertheless in case of such a 30% GHG reduction target within an international agreement, substantial financial resources would have to be made available to acquire additional credits generated through CDM.

[10] Carbon prices can be lower in non-ETS than €30 for those Member States that can achieve the non-ETS targets at a lower price.

9. IMPROVED ENERGY SECURITY : REDUCTION OF OIL AND GAS IMPORTS

Oil and gas import savings were estimated with the PRIMES model. Energy import prices derived through the POLES model take into account market power of for instance OPEC. Oil prices rise from US$ 55 per barrel in 2005 to US$ 61 per barrel in 2020, while gas prices are oil-indexed and hence follow a similar development. An exchange rate of US$ 1.25 per € has been used.

If the current high oil prices of around US$ 100 per barrel would continue, the costs due to the implementation of the proposed energy and climate change legislation reduce (see chapter 4, b).

Table III shows the impact of the various modelling scenarios. The value of the oil and gas imports saved equals 0.3% of GDP (i.e. import savings of €47 bn without CDM). Hence the EU economy would be less exposed to supply disruption and price shocks that might result from the concentration of supply in a limited number of countries. Achieving greenhouse gas reductions outside of the EU through investments in CDM implies that these energy security benefits would be reduced.

Overall it can be concluded that reducing greenhouse gas emissions and increasing renewable energy according to the targets agreed by the Heads of State makes the EU considerably less dependent on imports of oil and gas. Next to positive trade balance effects, this reduces the exposure of the EU economy to rising and volatile energy prices, inflation, geopolitical risks and risks related to inadequate supply chains that are not matching the global demand growth.

10. IMPACTS ON POWER GENERATION COSTS, ELECTRICITY PRICES AND ENERGY EXPENDITURE OF CONSUMERS

Table III indicates that the increase in average costs of electricity generation varies between 23 to 33% compared to PRIMES baseline developments, the lowest increase being in the case that part of the effort is met through investments in CDM (scenario 4 and 5). Effects on average electricity prices[11] (between 19 and 26%) are smaller than power generation costs increases since electricity prices include grid costs, which are largely unaffected.

It is important to note that the PRIMES baseline assumes a continuation of the EU ETS at carbon prices of €22 per tonne of CO_2 by 2020 with full free allocation of allowances and no specific cost pass through due to the inclusion of opportunity costs in the price setting for electricity. This might underestimate the electricity price level developments in the baseline. Therefore electricity prices increases could well be lower, at 10 to 15% by 2020 compared to baseline, taking into account today's carbon prices of € 20 per tonne of CO_2 or more, and the fact that carbon prices have been reported by several studies to be factored into current electricity prices already.

For final consumers increases in unit electricity prices are partially compensated by overall increased energy efficiency, which in the above policy scenarios is resulting in a reduction of

[11] These are electricity prices averaged over different types of consumers. Electricity prices are different for small, medium sized and large energy consumers.

electricity consumption of around 10%, thereby to a large extent countering the above mentioned increases in electricity prices.

These combined effects allow for rather moderate energy cost increases for households which are estimated on average to be some € 150 per year (in 2020). In the case of a continuation of today's high oil prices this amount would reduce further.

11. ADDRESSING COMPETITIVENESS IMPACTS FOR THE ENERGY INTENSIVE INDUSTRIES

As pointed out in chapter 8, the direct economic costs for implementing the greenhouse gas and renewable energy targets can be lowered through the use of CDM credits. Overall, therefore, this would strengthen the competitiveness of European industry. However, the impact of reducing recourse to CDM would vary – a very positive for innovative companies in the forefront of developing and producing new low-carbon technologies of the future, but a source of concern for those companies producing goods which are carbon and/or energy intensive and which are sold in highly competitive international markets where non-European players do not face similar constraints.

The EU is committed achieving an international agreement on climate change for the post-2012 period, for environmental reasons and for reasons related to fair competition for carbon and energy intensive activities. In this context the issue of carbon leakage needs to be taken into account. Simulations with the PACE model indicate that the achievement of the 20% independent GHG reduction without addressing the impacts on the energy intensive sectors could lead to a rise in emissions beyond business as usual in other world regions equal to 2.5% of EU27 emissions and hence reduce the overall effect of EU policies accordingly.

(a) Defining energy and carbon intensive sectors and subsectors

The impact of the proposed package on energy and carbon intensive industries will depend on the cost incurred relative to competitors outside the EU, the ability to pass on these cost in prices of products and services and the extent to which compensating measures are taken. Energy intensive industries are defined as business entities where the purchase of energy products and electricity amounts to at least 3.0% of the production value.

A recent Commission study finds that some 50 sub-sectors might require price increases for their products ranging from 0.1 to 5% to recoup costs imposed by an carbon price of €20 per tonne of CO2: cement and lime production, primary steel (blast oxygen furnace), aluminium production, production of primary container glass and some basic chemicals (ammonia, nitric acid, fertilizer production)[12]. It is important to note that this study does not evaluate the effects of the simultaneous introduction of the renewable target and CO2 mitigation policies. The study notes that the cement sector is unlikely to be significantly exposed to international competition due to high transportation costs, although there is a marked increase in trade in the Mediterranean basin. Because of limited ability to pass through additional costs, sectors most at risk are primary aluminium production, primary steel (blast oxygen furnace) and some basic chemicals. The competitiveness problem for energy intensive industries therefore

[12] Imposing a unilateral carbon constraint on European energy-intensive industries and its impact on their international competitiveness – data & analysis", DG Economic and Financial Affairs Economic Paper n° 297, forthcoming.

appears to be concentrated in a limited number of genuinely energy intensive industries while not generally affecting manufacturing industry as such.

(b) Specific measures for carbon/energy intensive sectors

The analysis is based on the PACE model that features a disaggregated regional and sectoral coverage as well as the relevant trading systems and policy measures. Different specific measures have been assessed and the following conclusions emerge from the results shown in tables V:

– *Global sectoral agreements* assuming realistic efforts by other regions would lead to substantially greater GHG reductions at the global level and have a positive, albeit modest, effect on the output performance of energy intensive industries. The overall economic effects (in terms of GDP) of the EU's GHG/renewables package would, however, not be much affected.

– *Free allocation of ETS allowances* to energy intensive industries on the basis of benchmarks contributes very strongly towards avoiding significant output losses without compromising total economy-wide performance as CO_2 and electricity prices are hardly affected. This instrument seems to be a very powerful tool to offset carbon leakage and adverse effects on energy intensive industries. This is even more the case if the free allocation would also allow for the compensation for indirect costs arising from the CO_2 content of energy intensive industries' intermediate energy consumption (e.g. electricity) on the basis of appropriate benchmarks.

– The *inclusion of importers* of energy intensive products in the EU ETS impacts positively on energy intensive industries' performance and generates some additional global GHG reductions. However, the net amount of allowances required by importers creates an important pressure on the ETS allowance price, which could have a negative impact on all ETS sectors and the economy as a whole and this would have to be addressed.

– *Access to CDM* significantly limits the output losses of the energy intensive industries and reduces carbon leakage considerably. Furthermore it has a positive impact on overall welfare costs. As such this instrument reduces the impact on energy intensive industries. Of course the GHG reductions achieved internally in the EU also reduce.

No single specific measure of this package alone will be sufficient to ensure the competitiveness of the most exposed energy intensive industries. The results in Table IV show that several of them can be linked to form a coherent and effective package, consistent with the Community's energy and climate change objectives.

12. REDUCING ADMINISTRATIVE BURDENS

(a) The EU ETS

The impact assessment for the review of the EU ETS has pointed out that the contribution of small and large emitters to the overall emissions covered by the EU ETS is uneven. Large installations representing only 7% of the total number of installations produce 60% of total emissions, while small installations representing around 14% of total installation only emit 0.14% of total emissions.

To reduce the administrative burden of this large number of small emitters the proposal of the Commission will maintain the current applicable threshold of 20 MW for combustion installations but will combine it with an emission threshold of 10 000 tCO2/year, as long as they remain below 25 MW. These small installations can only be excluded if measures are in place that achieve an equivalent greenhouse reduction in these installations.

(b) To facilitate the achievement of the renewable energy target

In the renewable energy sector, a range of administrative procedures are necessary for developing renewable energy projects, mainly to ensure compliance with EU as well as national legislation and policy objectives, such as environmental protection, public health and protection of workers. However such procedures, which cover licensing, planning permission, environmental impact assessments and grid access approvals, cause delays and raise costs and have a constraining effect on the deployment of renewable energy. The impact assessment shows that existing administrative procedures are hampering the development of renewable heating and cooling as well as electricity.

The Commission's proposal on renewable energy therefore requires Member States to take a range of actions that reduce the delays, uncertainties and administrative costs faced by European businesses and households.

ANNEX:

The following modelling tools have been used:

- PRIMES : This is a detailed partial equilibrium energy model dealing with all sectors and fuel types including their transformation in a technology rich way. It is detailed at Member States level, which allows for meaningful comparisons and aggregations on the basis of a harmonised approach. It was used to assess changes in the energy system in detail (e.g. investment costs, changes in fuel mix and consumption).

- GAINS : This is a model that allows to assess the impact of reducing non-CO_2 greenhouse gases (GHGs) taking into account the developments in the energy system. It was also used to assess the resulting impact on air pollution emissions other than GHGs.

- GEM-E3 : This is a general equilibrium model that represents all economic sectors and their interactions but has less detail on different mitigation technologies. It was used to assess the macro economic impacts at Member State level of reducing GHG emissions in the energy sector (e.g. GDP effects, effects on private consumption and employment).

- PACE: This is a global general equilibrium model similar to GEM-E3 but with more detail on electricity generation technologies. It was used to examine the sector specific impacts on energy-intensive industries of meeting a 30% renewable electricity target and the greenhouse gas objectives. It is more aggregate at Member State level than GEM-E3.

- POLES: This is a global partial equilibrium energy model that was used to assess the impacts of a future international agreement on the EU energy system. It does not include macroeconomic impacts.

Table I *Legally-binding targets for Member States*

(1)	(2)	(3)
Targets 2020	Reduction target in sectors not covered by the EU ETS compared to 2005	Share Renewables in the final energy demand by 2020
AT	-16.0%	34%
BE	-15.0%	13%
BG	20.0%	16%
CY	-5.0%	13%
CZ	9.0%	13%
DK	-20.0%	30%
EE	11.0%	25%
FI	-16.0%	38%
FR	-14.0%	23%
DE	-14.0%	18%
EL	-4.0%	18%
HU	10.0%	13%
IE	-20.0%	16%
IT	-13.0%	17%
LV	17.0%	42%
LT	15.0%	23%
LU	-20.0%	11%
MT	5.0%	10%
NL	-16.0%	14%
PL	14.0%	15%
PT	1.0%	31%
RO	19.0%	24%
SK	13.0%	14%
SI	4.0%	25%
ES	-10.0%	20%
SE	-17.0%	49%
UK	-16.0%	15%

Table II Economic impact of the building blocks of the proposals in terms of increased direct costs[13]

Cost as % of GDP 2020	Cost efficient reference option	Redistribution of Non ETS targets, no CDM	Redistribution of Non ETS targets, no CDM + Partial redistribution of auctioning rights EU ETS	Redistribution of Non ETS targets + Partial redistribution the auctioning rights EU ETS + with CDM	Redistribution of Non ETS targets + Partial redistribution auctioning rights EU ETS + with CDM + Redistribution of RES targets and full RES trade
	Option 1	Option 2	Option 3	Option 4	Option 5
EU27	0.58	0.61	0.61	0.45	0.45
AT	0.66	0.86	0.82	0.58	0.34
BE	0.76	0.83	0.93	0.69	0.70
BG	2.16	1.09	-0.35	0.14	-1.25
CY	0.09	0.08	-0.04	-0.03	0.07
CZ	1.12	0.49	0.03	0.20	-0.51
DK	0.29	0.57	0.50	0.22	0.11
EE	1.59	1.09	0.41	0.58	-0.53
FI	0.47	0.53	0.56	0.52	0.22
FR	0.39	0.39	0.37	0.32	0.47
DE	0.57	0.47	0.60	0.49	0.57
EL	0.97	0.74	0.53	0.60	0.59
HU	1.22	0.46	0.29	0.36	-0.40
IE	0.47	0.61	0.63	0.47	0.45

13 Measured as change in direct energy system cost, abatement cost in non CO2 greenhouse gases and costs to acquire CDM credits. This is not a loss in GDP. Macro-economic impacts are given in Table III.

IT	0.49	0.99	1.05	0.51	0.66
LV	1.10	1.60	1.50	0.88	-0.18
LT	1.02	0.52	0.36	0.43	-0.72
LU	0.54	0.89	0.91	0.59	0.70
MT	0.31	0.17	-0.36	-0.21	0.00
NL	0.28	0.34	0.43	0.28	0.32
PL	1.24	0.48	0.32	0.38	0.02
PT	0.87	0.48	0.54	0.57	0.51
RO	0.95	0.37	0.29	0.29	0.04
SK	1.17	0.79	0.74	0.60	0.26
SI	0.86	1.11	0.86	0.47	0.53
ES	0.70	1.20	1.08	0.62	0.42
SE	0.66	0.69	0.70	0.74	0.78
UK	0.49	0.36	0.36	0.34	0.41

Table III Overview of impacts at EU level for key scenarios of the impact assessment

Scenario	1	2	3	4
	Cost efficient reference scenario	**Redistribution of Non ETS targets, no CDM**	**Redistribution of Non ETS targets, but with CDM**	**Redistribution of the Non ETS targets, no CDM + Redistribution of the renewables targets, no RES trade.**
Carbon price ETS (€/tCO2)	39	43	30	47
Carbon price non-ETS (€/tCO2)	39	37	Max. 30	37
Renewable value (€/MWh)	45	44	49	51
CLIMATE &ENERGY[14]				
Reduction GHG over 1990 (%)	-20	-20	-14	-20
GHG reduction current ETS sector including emissions from aviation (% over 2005)	-18	-20	-13	-20
GHG reduction non-ETS sector (% over 2005)	-12	-10	-7	-10
Renewables share in final Energy Consumption (%)	20	20	20	20
Gross Energy Consumption (% change compared to baseline)	-10	-10	-5	-10
Direct costs (% of GDP)	0.58	0.61	0.45	0.66
Change Energy + non CO2 Costs + acquisition CDM credits (bn €)	91	95	70	103
Reduced oil & gas imports (bn €)	49	47	41	46
Increase in Electr. generation costs compared to no cost pass through of opportunity costs (%)	28%	30%	23%	33%
Increase in Average Electricity price compared to no cost pass through of opportunity costs (%)	23%	24%	19%	26%
Increase in Average Electricity price taking into account the inclusion of	10% to 15%			

14 Results by PRIMES/GAINS.

opportunity costs at present in power (%)				
MACRO-ECONOMIC EFFECTS[15]				
Change in GDP (%)	-0.35	-0.34	-0.21	
Change in private consumption (%)	+0.19	0.21	0.21	
Employment (% change BAU)	-0.04	-0.09	+0.05	
AIR QUALITY[16]				
Costs air pollution control (bn €)	-10	-11	-8	-11
Air pollution: SO2, NOX and PM2.5 (% reduction 2020)	-14	-13	-10	-13
SECTORAL IMPACTS[17]	(% change over BAU)			
Energy cost	6.4	6.3	4.4	6.8
Energy Cost per Value Added Industry	12.6	13.5	9.6	14.3
Energy costs per Value Added Tertiary	1.7	2.2	0.7	3.0
Production change top 3 Energy Intensive	- 2	- 2	< 1.5	>- 1.5

Table IV: Impact of international sectoral agreements and free allocation for energy intensive sectors[18]

	Reference Scenario**	**Reference Scenario + access to CDM for 25% of the reduction effort**	**Reference Scenario +international sectoral agreements**	**Reference Scenario +international sectoral agreements + free allocation through benchmarking for Energy Intensive Sectors**	**Reference Scenario +international sectoral agreements + inclusion of importers in the EU ETS**	**Reference Scenario +international sectoral agreements + inclusion of indirect emissions**
Share of renewable in EU energy consumption in 2020 (%)	**20**	**20**	**20**	**20**	**20**	**20**

15 Results by GEM-E3.
16 Results by GAINS.
17 Results by PRIMES.
18 Results by PACE.

Change in EU CO_2 emissions vs 1990 (% change)	**-16.8**	**-11.0**	**-16.8**	**-16.8**	**-16.8**	**-16.8**
Carbon leakage*(% of EU 2020 emissions)	**2.5**	**0.8**	**-14.1**	**-14.3**	**-14.4**	**-14.1**
World CO2 emissions (% of global emissions 1990)	**+47.0**	**46.5**	**+43.9**	**+43.9**	**+43.8**	**+43.9**
electricity price (% change vs.BAU in 2020)	**22.0**	**13.9**	**22.3**	**22.8**	**22.5**	**22.9**
CO_2 price (Euro per ton CO2).	**34.2**	**21.0**	**34.5**	**35.2**	**34.8**	**35.2**
Welfare (% change in GDP vs BaU in 2020)	**-0.69**	**-0.51**	**-0.69**	**-0.69**	**-0.66**	**-0.69**
Ferrous metals output (% change vs BaU)	**-8.0**	**-5.4**	**-7.4**	**-4.8**	**-6.8**	**-4.5**
Paper products output (%change vs BaU)	**-1.1**	**-0.7**	**-1.0**	**-1.1**	**-1.0**	**-1.1**
Mineral products output (%change vs BaU)	**-2.8**	**-1.8**	**-2.6**	**-2.3**	**-2.4**	**-2.4**
Non-ferrous metals output (%change vs BaU)	**-6.5**	**-4.2**	**-6.4**	**-6.0**	**-6.2**	**-5.0**
Chemicals output (%changevs BaU)	**-4.3**	**-2.7**	**-4.0**	**-3.7**	**-3.7**	**-3.9**

* Carbon leakage stands for the relative impacts of EU measures on the CO_2 emissions of other non-EU countries (in % of EU27 1990 emissions).
** The reference scenario includes partial auctioning for all sectors and free trading of GoOs