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ANNEX TO THE

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}
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Table of content

1. Procedural Issues And Consultation Of Interested Parties 9
1.1. Response to the opinion of the Impact Assessment Board 10
2. Problem Definition 11
2.1. Problem analysis 11
2.2. Specific problem drivers related to renewable energy sources 13
2.3. A coherent EU climate and energy policy response: the January 2007 package 16
2.4. Key principles for implementation - coherence between of the EU's 2020 climate and renewable energy targets 18
3. Objectives 19
3.1. General objectives: 19
3.2. Specific objectives: 19
3.3. Operational Objectives 20
4. Policy options and policy design choices 20
4.1. Relationship between GHG and renewables objectives 20
4.2. EU GHG reduction commitments 20
4.2.1. The EU GHG emission reduction target by 2020: emissions covered, required effort and base year 20
4.2.2. GHG reduction commitment, relationship with cap setting under the EU ETS 21
4.2.3. Defining the effort for EU ETS and non EU ETS sectors 21
4.2.4. Options for sharing of effort among Member States in the sectors not covered by the EU ETS 21
4.2.5. GHG reduction commitment, relationship with auctioning under the EU ETS 22
4.2.6. GHG reduction commitment, relationship with the flexible mechanisms, i.e. JI/CDM 22
4.2.7. The EU's 30% reduction target in case of an international agreement 22
4.2.8. Competitiveness issues 23
4.2.9. Indirect Impacts and Co-benefits 23
4.3. Options for implementing the renewable energy objective 23
4.3.1. Accounting method 24
4.3.2. Sharing the 20% renewables target among Member States 25
4.3.3. Improving the guarantees of origin regime 26

4.3.4. Virtual trade in renewable energy 27
4.3.5. Monitoring with national action plans 28
4.3.6. Reducing administrative, grid and market barriers 28
4.3.7. Achieving a 10% share of biofuels 31
4.3.8. State aid implications of binding targets for renewable energy 32
5. Analysis of impacts 32
5.1. Modelling tools used Options for implementing the renewable energy objective Relationship between GHG and the renewables objective 32
5.2. Relationship between GHG and the renewables objective 34
5.3. The independent EU GHG reduction commitment of at least 20% by 2020 compared to 1990 levels 36
5.3.1. The EU GHG emission reduction target by 2020: emissions covered, required effort and base year 36
5.3.2. GHG reduction commitment, relationship with cap setting under the EU ETS 38
5.3.3. Defining the effort for EU ETS and non EU ETS sectors 39
5.3.4. Sharing of effort among Member States in the sectors not covered by the EU ETS . 40
5.3.4.1. Cost-Efficiency 41
5.3.4.2. Equal Per capita emissions in the sectors not covered by the EU ETS 45
5.3.4.3. Equal Percentage reduction compared to 2005 45
5.3.4.4. Differentiation according to GDP/capita 46
5.3.5. GHG reduction commitment, relationship with auctioning under the EU ETS 51
5.3.6. GHG reduction commitment, relationship with the flexible mechanisms, i.e. JI/CDM 62
5.3.7. The EU's 30% reduction target in case of an international agreement 67
5.3.8. Competitiveness issues 70
5.3.8.1. Introduction 70
5.3.8.2. Impact of implementing the GHG and a renewable electricity target 70
5.3.9. Indirect Impacts and Co-benefits 76
5.3.9.1. Impacts air pollution, costs and benefits 76
5.3.9.2. Impacts energy supply security 78
5.3.9.3. Impacts on generation costs, electricity prices and energy costs per sector 79
5.3.9.4. Energy expenditures in relation to household incomes 80

5.3.9.5. Sensitivity analysis high oil prices 81

6. Implementing the renewable energy objective 82

6.1. Accounting method 82

6.2. Sharing the 20% renewable energy target among Member States 84

6.3. Improving the guarantees of origin regime 88

6.4. Virtual trade in renewable energy 95

6.4.1. Option 1: the status quo 95

6.4.2. Option 2: an open market for guarantees of origin 98

6.4.3. Option 3: a partially open market for guarantees of origin 106

6.5. Monitoring with national action plans 113

6.6. Administrative, grid and market barriers 116

6.7. Achieving a 10% share of biofuels 124

6.7.1. Options for ensuring the sustainability of biofuels 127

6.7.1.1. What aspects of the impact of producing biofuels should the criteria cover? 127

6.7.1.2. How should the impact of producing biofuels be measured? 133

6.7.1.3. What should be the required minimum level of performance for biofuels? 137

6.7.1.4. What should be the consequences of failing to meet the required minimum level of performance? 146

6.7.1.5. How should performance be verified? 147

6.7.1.6. Overall impact of the sustainability criteria 151

6.7.2. Options for promoting the development of second-generation biofuels and other especially desirable biofuels 151

6.7.2.1. Introduction 151

6.7.2.2. How should the set of especially desirable biofuels be defined? 152

6.7.2.3. What bonus should especially desirable biofuels receive? 153

6.7.2.4. Conclusion 154

6.7.3. Options for ensuring that fuel standards are compatible with the efficient achievement of the 10% target 155

6.7.3.1. Introduction 155

6.7.3.2. Is a change to a 10% blend of biodiesel in diesel technically feasible? 155

6.7.3.3. Is a change to a 10% blend of biodiesel in diesel needed? 156

6.7.3.4. What instrument should be used to implement such a change? 157

6.8. State aid implications of the introduction of binding targets for the use of renewable energy 158

7. Impact different options to implement the GHG and RES target -Preferred options and Conclusions 159

8. Annexes 165

8.1. Annex 1 165

8.2. Annex 2 168

8.3. Annex 3 169

8.4. Annex 4 170

8.5. Annex 5 172

8.6. Annex 6 175

8.7. Annex 7 179

8.7.1. Annex 7A 202

8.7.2. Annex 7B 203

8.8. Annex 8 205

8.9. Annex 9. 208

8.10. Annex 10 209

8.11. Annex 11 210

List of tables:

Table 1 Impact of stand alone and combined RES and GHG policies on the share of renewables, and CO2 and GHG emissions in 2020, without access to JI/CDM 34

Table 2: reduction in EU ETS (including outbound aviation) and–non EU ETS sectors to meet the 20% reduction in a cost-effective way 40

Table 3: Costs per GDP (increased energy system costs and Non-CO2 mitigation costs) to achieve both the GHG and RES target cost efficiently for the whole EU 42

Table 4: Emissions reductions in the sectors not covered by the EU ETS in the cost efficient policy case compared to 2005 43

Table 5: Macro economic impact of a cost efficient distribution and differentiated targets in the sectors not covered by the EU ETS.. 44

Table 6: Emissions reductions in the non-ETS in the cost efficient policy case for the EU with a modulation of the effort in the non-ETS sectors according to GDP 48

Table 7: Macro economic impact of a cost efficient distribution and differentiated targets in the sectors not covered by the EU ETS.. 49

Table 8 Macro economic impacts of auctioning given a cost effective achievement of the 20% GHG reduction commitment... 53

Table 9: Potential auctioning revenues generated in Member States in 2020......................... 54

Table 10: Auctioning rights redistribution key on the basis of GDP 57

Table 11: Options of relative shares per Member State of the total EU ETS auctioning cap for different auctioning rights distributions (in MtCO2) 58

Table 12: Impact on overall cost of different options to share the revenue of auctioning....... 59

Table 13: Macro economic impacts of distribution of auctioning rights taking into account GDP/Capita 61

Table 14 Impact of JI/CDM on the achievement of the independent 20% GHG commitment 63

Table 15: Example of impact on GHG reductions of limited access to JI/CDM type of mechanisms for the independent GHG reduction commitment................................ 64

Table 16: Impact of JI/CDM on the macro economic level... 65

Table 17: Impact of independent 20% GHG reduction commitment or 30% multilateral target on the EU CO2 emission reductions profile 68

Table 18 EU independent 20% GHG commitment or multilateral 30% target....................... 69

Table 19 Impact of transfers of renewable targets and JI/CDM on sector output in 2020 (% change compared to BAU).. 71

Table 20 Change in energy costs (fuel costs plus energy production costs) per exposed energy intensive sector in 2020 compared to the baseline for the EU-27 to achieve both the GHG and RES target... 72

Table 21 Change in the share of energy costs in overall production costsper exposed energy intensive sector in 2020 compared to the baseline for the EU-27 to achieve both the GHG and RES target 72

Table 22 Energy intensive sector impact GEME3 with auctioning in 2020 73

Table 23 Impact of sector specific measures to compensate loss of competitiveness 75

Table 24 Major air pollution impacts of policy options in 2020 for the EU27 77

Table 25: Reduction in oil and gas imports (bln €) 78

Table 26 Change in electricity generation costs, electricity price and energy costs by sector in 2020 compared to the baseline for the EU27 79

Table 27. Change in energy costs for households in 2020 in EU27 80

Table 28: Summary of impacts at EU level of a 20% renewable energy target for 2020 82

Table 29 Sharing the 20% renewable energy target among Member States, comparing options 85

Table 30: Summary of possible design features to strengthen the GO regime, and their advantages and disadvantages. 88

Table 31: Impacts administrative and market barriers of different options 123

Table 32 Assessment of the impact on the attractiveness of second-generation biofuels (shown in italic) of a system under which incentives for biofuels are proportionate to their greenhouse gas savings 139

Table 33 Cost of transmitting evidence of the verification to the fuel supplier 150

Table 34 Use of biofuels in 2020 156

Table 35: Example targets 2020 with distribution in the RES target and the GHG reduction targets for the sectors not covered by the EU ETS 160

Table 36 EU wide Impact distribution of RES target and the GHG reduction commitments for the sectors not covered by the EU ETS in 2020 161

Table 37: Impact at Member State level of distribution of RES target, GHG reduction commitments for the sectors not covered by the EU ETS and rights to auction allowances 162

Table 38: Macro economic Impact at Member State level of auctioning in the EU ETS and of distribution of auctioning rights and GHG reduction commitments for the sectors not covered by the EU ETS 164

Table 39185

Table 40191

Table 41193

List of figures:

Figure 1: 2005 shares of renewable energy in the EU 15

Figure 2: Reduction profile in the sectors not covered by the EU ETS after modulation taking into account relative GDP per capita 47

Figure 3: Impact of independent 20% GHG reduction commitment or 30% multilateral target on EU energy mix: 68

Figure 4 Energy costs for households by member state in 2020 (€/year) 81

Figure 5 % differences in renewable energy shares between 2001 and 2005.......................... 87

Figure 6: System costs of existing tracking systems.. 91

Figure 7: Expected total annual costs for the E TRACK system in Europe 93

Figure 8: Cost developments for the EU ETS (2005-2006)... 94

Figure 9: Recent and current support schemes in Member States 97

Figure 10: The flow and transfer of guarantees of origin 100

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

On 10 January 2007 the Commission adopted a Communication an Energy policy for Europe and a Communication "Limiting Global Limiting Global Climate Change to 2 degrees Celsius"[1] calling on the Council and European Parliament to endorse an independent EU commitment to achieve at least a 20% reduction of greenhouse gases by 2020 with an objective in international negotiations of 30% reduction by 2020 compared to 1990 levels.

On the same date, the Commission adopted a Communication on the Renewables Roadmap which proposed to establish a binding target of 20% for the renewable energy share of EU energy consumption and a 10% minimum target for the biofuels share of transport fuel consumption.

The Communication was supported by an impact assessment including extensive public consultations, inter-service consultation, modelling and analysis. These included public consultations on the Energy Green Paper (March – September 2006), the revision of biofuels policy (April-July 2006), heating and cooling in renewable energy (August-October 2006) and biofuels sustainability (April-June 2007).

The main issues addressed in the roadmap were debated in the public consultation on the Energy Green Paper and the Strategic European Energy Review between March and September 2006. This process included consultations with Member States, the European Council, the European Parliament, citizens, stakeholder groups, civil society organisations, NGOs and consumer organisations, discussions on various forums, a web page created on the Europa website including a questionnaire and a mailbox for unresolved questions.

The questions raised in the public consultation on the Green Paper included whether renewable energy can contribute to ensuring access to energy at reasonable prices in Europe; whether it can contribute to diversification of the energy mix and sustainable development in the EU; and whether defined long-term targets and an action plan to promote renewable energy are important for the further development of clean and renewable energy sources in the EU.

There was wide support for a stronger policy on renewable energy sources and notably to a longer-term target for renewable energy, with suggestions ranging from 20% in 2020 to 50% and more by 2040/2050. The use of obligatory targets was widely supported, as was the internalisation of external costs.

A European Commission inter-service group met between April 2005 and November 2006 to discuss targets for renewable energy overall, biofuels, electricity and heating and cooling. Finally, the European Energy and Transport Forum (representing energy businesses, of networks and infrastructure managers, consumers, unions, environmental protection and safety organisations, and academics) was also consulted on the long term strategy for renewable energies and on sectoral approaches. Industry pleaded in favour of sectoral targets and Member States argued for subsidiarity and flexibility.

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[1] COM(2007) 2.

On biofuels there is clear consensus on the desirability to establish a European system to guarantee environmental sustainability of the policy. The Commission will reflect on ways of taking this forward.

The Spring Council of March 2007 endorsed the Energy and Climate change package and requested the Commission to prepare a proposals to implement the this package.

In accordance with the principles of good governance and better regulation, the Commission services have carried out an impact assessment (IA) to help orient and structure the preparation of the new legislation and to contribute to the setting of the preferred options for greenhouse gases reduction and renewable energies. This analysis is in line with the Commission Impact Assessment Guidelines[2] and takes into account the principle of proportionality.

This impact assessment on the proposal for a Directive to implement a policy on renewable energy sources draws heavily on the documents prepared in support of the Communications of the Strategic Energy Review (SEC(2006)1719/2, SEC(2006)1721/2, COM(2006)849/2).

1.1. Response to the opinion of the Impact Assessment Board

The Impact Assessment Board's opinion included the following main recommendations:

- The final report should be accompanied by an understandable executive summary including a single overview table:

> The impact assessment as presented to the board was summarised in a shorter document, including relevant technical tables. This document was still a little larger than 25 pages and became the main impact assessment whereas the more detailed extended impact assessment was annexed.

- The assessment of policy measures in the renewable sector need to be strengthened:

> More detailed analysis and tables exploring the impact of the package as a whole on each Member State have been added; an inter-service working group revised the discussion and text on GO trade; the SG administrative costs model was applied and a discussion of administrative costs included wherever relevant.

- Impact of oil price volatility on modelling results needs to be discussed.

> A sensitivity analysis was included with a high oil price in chapter 5.3.9.5.

- The IA should contain clear indications of modelling limitations and ensure coherence:

> A clear description was added at the start of chapter 5 of the models used and their limitations. Model results were as far as possible aligned.

- Total costs and benefit need to be included at Member States level:

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[2] SEC(2005) 791.

The tables in Chapter 5 now includes the effects of different policy scenarios with different models at Member State level. Furthermore summary tables at Member State level are given in Chapter 7.

- Impact of the use of flexible Kyoto Mechanisms such as CDM need to be thoroughly assessed:

The impacts are now explicitly addressed in chapter 5.3.6. Also the chapter 5.3.8 on competitiveness impacts now includes a discussion of the effects of access to such flexible mechanisms.

- Analysis of distributional impacts should be added:

Chapter 5.3.9 includes several sub-chapters that discuss the different distributional impacts and other direct and indirect costs. Chapter 5.3.9.1 was added on indirect impacts including air pollution costs, chapter 5.3.9.2 discusses the impact on energy imports, chapter 5.3.9.3 discusses the impacts on electricity costs and chapter 5.3.9.4 discusses the impacts on energy expenditure in relation to household incomes.

- External competitiveness impacts need to be assessed i.e. for energy intensive sectors:

A new chapter 5.3.8 addressing specifically these issues was added.

The board also suggested other analytical improvements that were taken on:

- More details on the new energy baseline as developed by DG TREN are provided in Annex 1.

- Advantages of full auctioning of CO2 were made clear. This is done in particular in chapter 5.3.5 and also included in the chapter on competitiveness 5.3.8.

- Impacts of choice of sustainability criteria and methodologies should be analyzed. This was included in chapter 6.7.

Another element that was introduced after discussions with the Impact Assessment Board is a brief discussion on why the impact assessment uses nominal GDP and not GDP at Purchasing Power Parities (see chapter 5.3.4.1).

2. PROBLEM DEFINITION

2.1. Problem analysis

Climate change is caused by greenhouse gas (GHG) emissions stemming largely from energy. Climate change is already occurring. Average global temperatures will increase by more than 2° Celsius above pre-industrial levels by the end of this century if no additional policies are undertaken that reduce GHG emissions[3]. The IPCC's 4th Assessment Report pointed out that with this level of temperature increase, negative impacts in all regions globally become substantial and the risk of large scale irreversible impacts becomes real. These include for

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[3] Forecast at Intergovernmental Panel on Climate Change (IPCC), 4th Assessment Report (IPCC 2007).

instance the melting of the Greenland ice cap and the eventual loss of one third of global biodiversity.

In June 1996, the Council endorsed the objective to limit global average temperatures increases to no more than 2ºC above the pre-industrial level. This level has been confirmed repeatedly by the European Council as the EU's overriding climate change policy objective.

This will require broad participation in the effort to reduce GHG emissions. It requires a peak in global GHG emissions before 2025 and then a reduction by up to 50 % compared to 1990 levels by 2050. GHG emissions from the energy system from fossil fuel combustion represent around 70% of global GHG emissions[4] and they are increasing rapidly. Without additional climate change and energy policies, the IPCC expects GHG emissions from the energy sector alone to grow between 40 to 110% between 2000 and 2030. Attaining the 2°C objective will thereby foremost require a dramatic shift downwards in the GHG emissions of our energy system through more efficient use of energy sources, energy conservation and using energy sources with a lower carbon content.

Simultaneously with the climate change challenge, the EU faces a closely related challenge, namely in its energy sector. Due to soaring demand energy prices have continued to increase sharply since the beginning of 2004. In addition, due to continuing political instability and political interference in energy supplies, energy markets have become more volatile. Uncertainty on the mid and long term prospects for sufficient energy supply have increased. The EU is becoming increasingly exposed to the effects of price volatility and price rises on international energy markets. With the release of it’s the 2007 World Energy Outlook the International Energy Agency states that "Although production capacity at new fields is expected to increase over the next five years, it is very uncertain whether it will be sufficient to compensate for the decline in output at existing fields and meet the projected increase in demand. A supply-side crunch in the period to 2015, involving an abrupt escalation in oil prices, cannot be ruled out."

Europe is also confronted with an increasing dependence on energy sources that are located outside the EU. Without additional measures the EU's import dependence will jump from little more than 50% of total EU energy consumption today to 67% in 2030. Reliance on imports of gas is expected to increase from 58% to 84% by 2030, of oil from 82% to 95%. These imports will come increasingly from a limited number of countries, often in less stable regions.

This combination of elements particularly exposes the EU economy to future energy crises. The EU must decrease its exposure to external factors by giving the right incentives to the EU’s internal energy market to consume less energy through improved energy efficiency and energy conservation that at the same time come from sustainable and secure energy sources. This requires the development and deployment of new technologies, both to produce energy sustainably and consume it much more efficiently. Such innovations will render the EU economy as a whole more competitive.

These types of changes in the energy system can also reduce overall GHG emissions substantially given the right incentives. As such the challenge to reduce GHG emissions and the challenge to make our energy system secure and sustainable need to be addressed

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[4] Global greenhouse gas emissions excluding emissions from deforestation.

simultaneously to ensure that synergies are fully exploited. Examples can for instance already be found in the market for renewable technologies where the EU has become a global leader, stimulating technological innovation, reducing GHG emissions, increasing energy security and generating jobs and income.

2.2. Specific problem drivers related to renewable energy sources

Market failures

The identified problems result from the inability of the market to shape demand and supply of energy products in a way that is consistent with the need for security, sustainability and technological leadership. This is due to a number of market failures. This section describes a range of market failures and policy failures that the renewable energy sector suffers and which result in suboptimal levels of renewable energy production.

Negative externalities

External costs: conventional energy sources have significant external costs (air pollution, green house gas emissions, high price/risk premiums and government expenditure due to high insecurity of supply…). The failure of conventional energy prices to include these costs constitutes the equivalent of a subsidy and a competitive advantage for conventional energy sources: were external costs internalised, the costs of conventional energy borne by consumers would rise and so lower the relative price of renewable energy sources and technologies.

Subsidies

In the imperfect energy market there remain a large number of distortions, including a wide range of explicit and implicit subsidies to all parts of the energy sector. These include direct cash transfers to industrial producers or consumers, low interest loans, tax exemptions and rebates, market access restrictions and regulatory support mechanisms. The “first best” solution is to remove all unjustified subsidies. A second best solution is to try to ensure that the subsidy regimes that exist distort the market as little as possible.

Critical mass and technological uncertainties

The purely financial costs of innovative, small scale technological developments have proportionally higher investment costs than mature, large scale technologies. Being at an early point on their technology learning curve means that the above cost-related market imperfections have a disproportionate effect on innovative and developing technologies and businesses. This is particularly true for nascent renewable cooling technologies. Technological uncertainties combined with questions of integrating decentralised energy into the centralised grid infrastructure, all adds to the risks faced in the development of new technologies and the cautious perception, of consumers, developers and investors.

Imperfect competition

Despite ongoing measures to open and unify the European energy markets, large incumbents still dominate most national energy markets. This was recognised in the Commission's recent paper "An Energy Policy for Europe"[5] which recognised the need to develop a more competitive internal energy market. Weak competition undermines innovation and the development of novel technologies or approaches to meeting energy needs. In the renewable energy sector existing dominant energy companies have no incentive to encourage the uptake of small scale or off-grid technologies which reduce their energy sales. On the contrary, energy companies with market power are likely to pose objections and create barriers to the uptake of competing energy sources and technologies.

Information failure

Renewable energy sources are subject to significant information failure: new technologies that are applied at plant and household level (e.g. solar water heating, heat pumps…) can be slow to find public acceptance, the market for installation and maintenance services is often inadequately informed and trained, resulting in technology breakdowns and a perception of unreliable technologies.

The poor information flows can also occur during production, when energy suppliers are unaware of quality standards, regulators fail to create the right legal or institutional framework (e.g. municipal planning rules), and capital markets fail to acknowledge technology learning and reductions in risk. Such failures can also result in poor supply chain development.

Financial short-sightedness

The higher costs, particularly the higher investment costs, and the lack of information in the market often result in “financial short sightedness”: a barrier to uptake whereby consumers are reluctant to make higher upfront investments despite the probability that subsequent savings in operating costs will often provide a net financial benefit over the lifetime of the equipment. Regulatory stability and long term mandatory targets are key for reducing this problem.

For most of the technologies, initial investment costs are substantially higher than fossil fuel alternatives. This often means that renewable technologies are not considered or rejected at the moment of investment, despite lifetime cost savings. Architects, designers and engineers for instance, focus on their clients' initial capital costs rather than lifetime savings, which together with concerns regarding the uncertainties of life time, quality and reliability, render the whole prospect is unattractive. This is a case of poor information combined with cautiousness and financial myopia and discourages the use of renewable energy technologies.

Current policies to address market failures

Uneven support and promotion

Whilst a range of measures have been implemented in certain regions and Member States, to deal with these market failures, there are areas of the EU where little effort has been made to harvest the renewable energy resources available. The effort and "burden" of developing the renewable energy sector has not been evenly shared, and this needs to be addressed.

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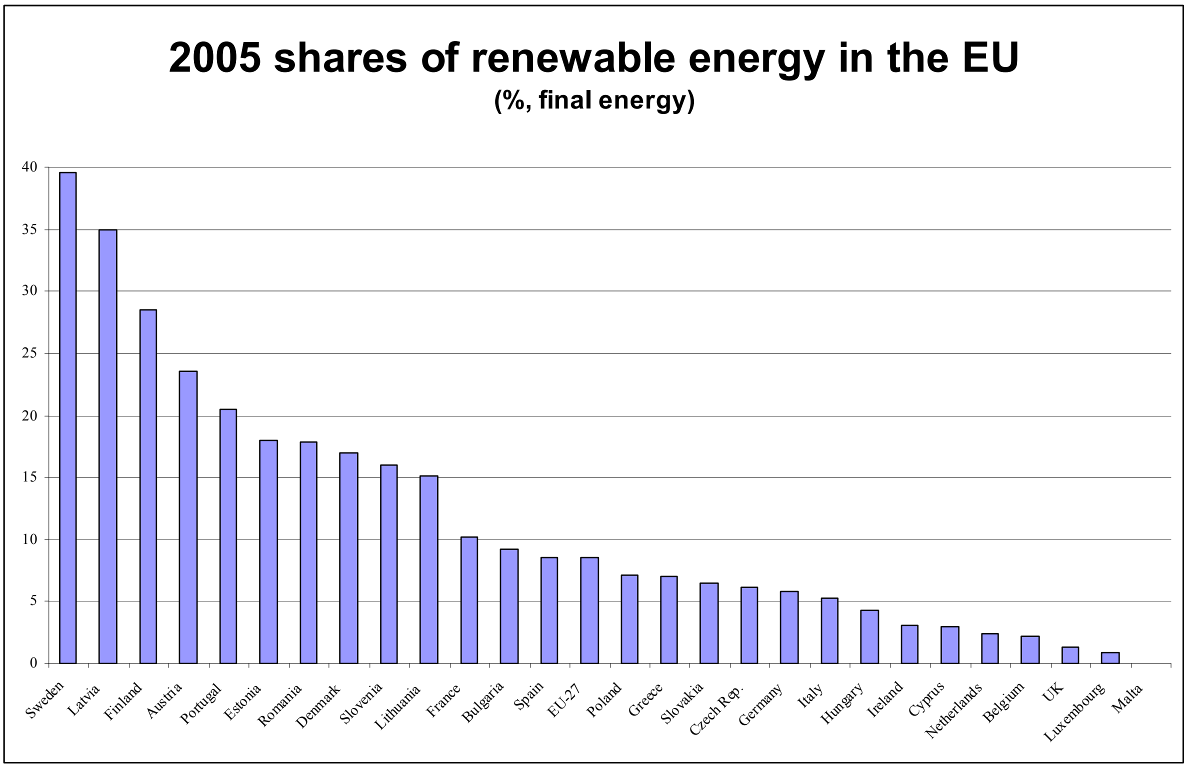
[5] COM (2007) 1.

Figure 1: 2005 shares of renewable energy in the EU



This uneven application of policy across sectors – the lack of effective policies and clear targets – contributes to the failure to fully exploit the potential of renewable sources, particularly for heating and cooling.

Barriers

An additional problem is that whilst some such measures have proved successful at the regional level, the different regulatory, planning, financial and standardisation measures can themselves form a barrier to the growth of the single market in this area.

The various different national regulations, labelling, standardisation, testing requirements and certification procedures raise costs and cause uncertainty, confusion and delays. The consequence is that companies have difficulty penetrating other Member States' markets, hindering the growth of SMEs and the achievement of greater economies of scale. This in turn reduces the market penetration of renewable technologies, slows the growth towards renewable energy targets and stunts the growth of the renewable energy technology sector.

Current EU policies and Community right to act

For environmental, security of supply and industrial policy/innovation reasons, European energy policy promotes the development and growth of the renewable energy sector. Targets for 2010 have been established in existing legislation for renewable-sourced electricity (21% by 2010) and for biofuels for transport (5.75% by 2010) and the renewable energy roadmap establishes 2020 targets for renewable energy overall (20%) and for biofuels for transport (10%).

If current trends continue, these targets will not be reached. If so, poor air quality and other pollution from conventional energy sources will continue to grow, the EU will fail to achieve its climate change policy objectives, the European Union will continue on its path of increasing energy dependence, leading to higher risks of greater price volatility and price spikes, and risks of supply disruption. Finally, the economic benefits of a prosperous, dynamic, innovative energy technology sector will be reduced, undermining the Lisbon objectives.

The Community has the right to act under Articles 95, 174 and 175 of the Treaty. These clearly outline the grounds for action: ensuring the smooth operation of the single market for energy technologies, preserving, protecting and improving the quality of the environment, ensuring the prudent and rational utilisation of natural resources, and promoting measures at international level to deal with regional or worldwide environmental problems.

The failure to develop a true European energy policy has resulted in uncoordinated and sometimes inconsistent national and regional energy policies which have failed to take advantage of the Community's economic weight and economies of scale.

The legislative proposal on renewable energy source does not aim at solving all the problems mentioned in this section, but it would solve an important part of them. The 20% mandatory target proposed in the renewable Directive will develop an important critical mass and a stable long term vision, triggering further investments. Barriers will be addressed, balancing firmness and a sufficient degree of flexibility in order to adapt to national, regional and local conditions. Improved information will aim to increase quality and public acceptance and an scheme guaranteeing biofuels sustainability will be developed.

Other Commission initiatives are also part of the solution. The new Commission proposal on the internal electricity market aims at increasing transparent competition and the new European Strategic Energy Technology Plan intends to push the role of technologies to contribute to energy policy goals.

2.3. A coherent EU climate and energy policy response: the January 2007 package

In order to tackle simultaneously the challenges to reduce greenhouse gas emissions, improve energy security and ensure long term EU competitiveness, the Commission proposed an integrated climate change and energy package on 10 January 2007. This package covered several Communications in the field of energy and climate change policies.

The Communication "Limiting Global Limiting Global Climate Change to 2 degrees Celsius"[6] illustrated that achieving the 2°C objective is economically and technically feasible. This will require developed countries to continue to take the lead in cutting their greenhouse gas emissions and efforts by developing countries to significantly reduce the growth of their emissions before 2020. The European Commission recommended that the EU should pursue in the context of international negotiations the objective of a 30 % collective reduction in greenhouse gas emissions (GHG) by developed countries by 2020 compared to 1990 levels. Furthermore, until such an ambitious international agreement is concluded, the Commission proposed that the EU should already take on a firm independent commitment to achieve at least a 20 % reduction of GHG emissions by 2020.

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[6] COM(2007) 2.

The European Emissions Trading Scheme (EU-ETS) is the single most important climate change policy instrument in the EU that is also critical to create additional incentives that stimulate changes in how Europe generates and uses its energy. The Communication “Building a global carbon market”[7] started the process of the review of the EU-ETS in order to improve and extend its working for the period after 2012 when its 3rd trading period begins. The Commission has already proposed to include aviation in the EU ETS[8]. The Council confirmed the central role of the EU ETS in changing our energy system and reducing greenhouse gas emissions and requested the Commission to finalise its review in due time to strengthen the EU ETS and broaden its scope.

Several other climate change policies are also in preparation by the Commission. For instance, the Commission adopted a comprehensive new strategy in its Communication “Results of the review of the Community Strategy to reduce CO_2 emissions from passenger cars and light-commercial vehicles”[9] with the aim achieve the long-established objective of limiting average CO_2 emissions from new cars to 120 grams per km by 2012 - a reduction of around 25% from current levels.

In “An Energy Policy For Europe”[10] climate change was put forward as the central objective along side increasing energy security and improving EU competitiveness. Several new ambitious energy policy objectives were proposed. It was emphasized that the Internal Energy Market needs to be further developed in order to create a more robust, competitive energy system that is more resilient towards external shocks and more receptive to new technologies and low carbon energy sources such as renewable energy sources. This requires additional efforts in unbundling, more effective regulation and improvements in infrastructure and network security.

The Commission had already adopted the “Energy Efficiency Action Plan”[11] with the aim to improve energy efficiency with 20% by 2020. In its “Renewable Energy Roadmap”[12] a binding target of increasing the level of renewable energy in the EU's overall mix to 20% by 2020 was proposed (the RES target). This 20% renewables target includes a proposal for a binding minimum target of 10% for biofuels in vehicle fuel by 2020, following the “Biofuels Progress report”[13]. All these targets were endorsed by the 2007 Spring Council, which stated that the binding character of the biofuels target is appropriate 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 The Council requested the Commission also to look into an overall coherent framework for renewables energies which could be established on the basis of a Commission proposal with Member States' full involvement.

Finally, the Commission also adopted a “European Strategic Energy Technology Plan”[14] that underlined several sectoral objectives to develop and deploy new energy technologies in the

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[7] COM(2006) 676.
[8] COM(2006) 818.
[9] COM(2007) 19.
[10] COM(2007) 1.
[11] COM(2006) 545.
[12] COM(2006) 848.
[13] COM(2006) 845.
[14] COM(2006) 847.

EU. One of these objectives is to ensure that future power generation becomes near zero in carbon emissions. In addition to the renewables target a Communication was adopted on "Sustainable Power Generation from fossil fuels"[15] to accelerate the development and deployment of clean fossil fuel power generation fitted with carbon capture and storage technologies. The Commission has prepared a proposal for an enabling a legal and policy framework for carbon capture and geological storage (CCS) and a mechanism to stimulate the construction by 2015 of 12 zero carbon fossil fuel power plants equipped with CCS.

On March 9, 2007 the Council endorsed the package and agreed on a set of specific targets to reduce our greenhouse gasses, increase the share of renewables and become more energy efficient (see chapter 3.2).

The Council recognised that the implementation of these targets should be based on a combination of Community measures and on efforts to be undertaken by Member States. The Council invited the Commission, in close cooperation with the Member States, to start a technical analysis to form the basis for further in-depth discussion. This impact assessment addresses this request.

2.4. Key principles for implementation - coherence between of the EU's 2020 climate and renewable energy targets

The implementation of the agreed objectives should be consistent with a number of key principles..

Cost-effectiveness – Depending on the policy design, achieving the agreed objectives can have significant economic impacts and therefore the implementation of cost-effective policy instruments is crucial. Policies need to take into account ex-ante national circumstances in a differentiated manner, e.g. likely developments in GDP, industry and energy sectors, and the availability of low cost emission abatement potential. However, there will always remain uncertainty about the final ex-post outcome in 2020. If there would be no flexibility on how to attain the targets, there could be costly impacts if circumstances would change unexpectedly in the future. Therefore cost effective market based policy instruments need to provide sufficient flexibility on how to meet the targets.

Internal market and fair competition – Policy instruments need to be consistent and create a level playing field in the EU that ensures fair competition among EU industry in the context of the internal market. This could be achieved through the use of market based instruments such as the EU-ETS and community wide measures such as product standards that ensure a level playing field. There is in addition a need to ensure consistency with related policy instruments, such as environmental state aid guidelines.

Subsidiarity – A number of sectors need also to be considered from a perspective of subsidiarity where Community initiatives need to support national policies and measures. In these sectors Members States hold key competences to define policies and measures such as the implementation of performance standards for buildings, more 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.

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[15] COM(2006) 843.

Fairness – The European Council in March 2007 showed that, alongside its consensus on cutting emissions and boosting renewables, there is a clear expectation that Member States' different socio-economic circumstances should also be taken into account.

Competitiveness – Until a comprehensive international agreement is reached, carbon leakage could occur undermining the overall environmental objective of EU climate and energy policies. In addition, energy-intensive sectors particularly exposed to international competition could be significantly affected. Policy instruments should not unduly decrease the international competitive position of EU energy-intensive sectors and flanking measures could be considered if no international agreement can be reached.

Administrative burden – the implementation of policy instruments can have an administrative cost on all involved: on public administrations at national and European level and on private stakeholders such as industry. It is important to determine if any extra administrative burden or cost is proportionate and appropriate.

3. OBJECTIVES

3.1. General objectives:

The EU has three general objectives which interact with each other:

(1) - to limit global average temperature increase to not more than 2°C above the pre-industrial level.

(2) - to make the EU economy energy secure.

(3) - in line with the Lisbon Strategy, to make the EU the most competitive economy in the world, in particular with respect to new energy technologies such as low carbon energy production technologies and more energy efficient consumption technologies.

3.2. Specific objectives:

The **specific objectives** to achieve the 3 general objectives that have been set by the European Council, i.e.:

a) to reduce the EU's greenhouse gas emissions by at least 20 % below 1990 levels by 2020, which should be increased to 30 % in the context of a global and comprehensive international agreement.

b) to achieve a share of 20 % of renewable energy, and 10 % of biofuels by 2020.

Climate change policies that reduce GHG emissions from energy use have a direct impact on the energy system. Similarly energy policies have a direct impact on overall GHG emissions. Both need to be implemented in such a way that they are mutually supportive. Furthermore they need to address particular sectors where greenhouse gas reductions are difficult to attain and security of supply problems are more acute, such as for instance the transport sector. More concretely this impact assessment will specifically analyse the impact of a number of policy options as set out in detail below.

3.3. Operational Objectives

a) The GHG reduction commitments

The impact assessment will address the GHG commitment, i.e. the firm and independent GHG reduction target set by the EU of at least 20% and the more ambitious target of 30% if a sufficiently ambitious international climate change agreement can be reached and how the efforts could be shared among the Member States.

A closely related question to this is what role there should be for reductions of GHGs outside the EU after 2012 (e.g. Joint Implementation (JI) and Clean Development Mechanism (CDM)). This concerns both the EU ETS and the non-ETS sectors.

b) The RES targets

This impact assessment will address how the effort can be shared between Member States to achieve the renewables target including the biofuel target.

Specifically for the RES target this impact assessment will consider the additional Community policies need to be put in place to facilitate the achievement of the renewables target.

Given that GHG policies are an incentive to invest in RES and RES policies also reduce in general GHG emissions, the interaction between both targets and policy instruments to support them will be assessed.

4. POLICY OPTIONS AND POLICY DESIGN CHOICES

4.1. Relationship between GHG and renewables objectives

The relationship between GHG and renewables objectives needs to be assessed and to what extent they influence the achievement of the different targets in the different main sectors.

4.2. EU GHG reduction commitments

Overall, the options and choices under consideration include the effort that each individual Member State needs to undertake in order to fulfil the EU wide independent GHG reduction commitment of at least 20% by 2020 compared to 1990, as well as the key policy options to achieve them. Furthermore it needs to be assessed what the impact would be of a 30% GHG reduction target if an international agreement would be concluded.

4.2.1. The EU GHG emission reduction target by 2020: emissions covered, required effort and base year

In order to assess the impacts of the agreed objectives, it needs to be determined which emissions need to be covered in the assessment, in particular in relation to bunker fuels and LULUCF (Land use, land use change and forestry). It needs also to be decided what base year is most appropriate for policy design and analysis of the impacts.

4.2.2. GHG reduction commitment, relationship with cap setting under the EU ETS

In principle, two main options exist for cap setting in the EU ETS:

> i) The EU-ETS allocation procedure is kept as it is, with Member States proposing the cap of their ETS sector with Commission oversight.
>
> ii) The EU-ETS cap is determined at EU level through co-decision of the Council and the European Parliament. A direct consequence of cap setting directly through EU legislation level is more harmonised allocation rules to further allocate allowances to sectors and installations in the EU.

As such these two options would have a direct impact on the way the GHG reduction commitment would be defined.

The first option would still require the entire GHG reduction commitment to be shared per Member State across all its GHG emissions. Only afterwards Member States would determine the caps for their respective ETS and Non-ETS sectors.

In the other option, the efforts would first be shared at EU level between the ETS sectors and the Non-ETS sectors. There still would be a sharing of efforts per Member State to achieve the GHG emission cap, but one that only focuses on remaining emission cap for the Non-ETS sectors.

4.2.3. Defining the effort for EU ETS and non EU ETS sectors

There are many methodologies and options possible, to determine the EU-wide ETS cap and, at the same time, how much reductions are necessary in the non EU ETS sectors, such as:

- - Equal marginal abatement cost in EU ETS and non EU ETS sectors
- - Equal reduction compared to 1990 in both sectors
- - Equal reductions compared to 2005 in both sectors
- - Equal reductions compared to the expected emissions in 2020 in both sectors

Of course, considering the earlier described relationship between GHG and RES policies, these methodologies should take into account the impact of RES deployment.

4.2.4. Options for sharing of effort among Member States in the sectors not covered by the EU ETS

Also for determining national targets in sectors not covered by the EU ETS there are different criteria possible. Considering the important economic implications and differences in energy mix, economic and social situation, different reduction potential, the Commission deemed it necessary to analyse in depth various methodologies for a fair target sharing:

- – equal marginal abatement cost ('efficiency')
- – equal per capita emissions ('capita')

- equal emission reductions with respect to historical emissions: 2005 (effort)
- differentiated reduction targets depending on the relative GDP/capita of the different Member States ('GDP/capita')

Again these methodologies should take into account the impact of RES deployment.

4.2.5. GHG reduction commitment, relationship with auctioning under the EU ETS

Under the EU ETS review it is assessed if and in how far more auctioning in the EU ETS sectors is being proposed. It needs to be assessed if there is an impact of auctioning for the achievement of the RES and GHG commitments. Firstly this could be of a macro economic nature. Auctioning generates substantial revenue that will be recycled in the economy and it needs to be assessed what the impact might be on the macro economic level both for the EU as a whole as within Member States.

Secondly, auctioning could have an impact on the extent that the carbon value is incorporated or not in the final consumer price, as for instance highlighted in the debate of inclusion of opportunity costs in the electricity sector where there are indications that this seems to occur already even without auctioning. Such price effects could have indirect consequences, leading to more efficiency, lower electricity demand and thus lower carbon emissions in EU-ETS sector.

4.2.6. GHG reduction commitment, relationship with the flexible mechanisms, i.e. JI/CDM

There is a direct relationship between the extent that GHG commitment is achieved in the EU or not, and the access to reductions outside the EU through e.g. JI or CDM. Access to the so-called flexible mechanisms reduces costs but also decreases the achieved reductions in the EU. As long as the EU takes on an independent commitment without sufficient commitment in regions outside of the EU, the supply of credits from the flexible mechanisms outside of the EU will be abundant and the resulting carbon price for these credits would be low. As such unlimited access to the flexible mechanisms will lead to lower GHG reductions within the EU. This will reduce overall costs at the same time decrease incentives for structural changes in our energy system not creating long term benefits for the domestic environment, domestic energy security and competitiveness. For instance, JI/CDM abatement projects would reduce the incentive from GHG mitigation policies towards the deployment of renewables in Europe and thus the attainment of the EU RES targets. Unlimited access to JI/CDM at low costs could also affect EU leadership on domestic action negatively.

Therefore options will need to be considered if and to what extent allowing for use of JI/CDM would affect overall cost effectiveness and the achievement of other policy objectives, in both EU ETS and non EU ETS sectors.

4.2.7. The EU's 30% reduction target in case of an international agreement

The Commission's Communication Limiting Global Climate Change to 2 degrees Celsius had proposed that the EU would pursue in the context of the international negotiations the objective of a 30 % reduction in GHG by developed countries by 2020 compared to 1990 levels together with a broadening of participation by the developing countries. The Council endorsed a 30% GHG reduction by 2020 compared to 1990 as its contribution to a post 2012 agreement provided that other developed countries commit themselves to comparable emission reductions.

The impact assessment needs to address how the EU will take into account such an international agreement in the effort sharing between Member States

The two different reduction targets of 20%/30% would be realised in two totally different contexts. In the former, the EU would be acting on its own in the period after 2012. In the latter the global community would be acting on climate change. Relative prices for energy sources and credits from the flexible mechanisms are likely to differ substantially between the two scenarios. In a global framework, provided that the aggregated ambition level of all participants would be sufficiently high, there would be more of a case to allow use of the flexible mechanisms as resulting carbon price should be high enough to promote technological and structural change also in the EU.

Therefore it needs to be assessed to what extent a 30% reduction target allowing extensive global trading differs from a 20% reduction commitment as assessed in the above and to what extent this would lead to changes in the overall efforts by Member States.

4.2.8. Competitiveness issues

The implementation of the energy and climate change package will require a substantial change in our energy system. For large industrial installation this change will be implemented through the EU ETS .

It needs to be assessed what the impact of this could be on industrial sectors, certainly for those sectors that are confronted with competition from outside of the EU where no comparable independent targets are foreseen.

4.2.9. Indirect Impacts and Co-benefits

Other indirect impacts and co benefits of the implementation of the package need to be assessed. The impact assessment looks in more detail at the impacts on air pollution, pollution, energy supply security, electricity generation costs, electricity prices and energy costs per sector and the overall impact on household incomes.

4.3. Options for implementing the renewable energy objective

The context for the implementation of the renewable energy Directive is set by the Commission's original proposal (the Renewable Energy Roadmap of January 2007[16]) and by the positions taken on this proposal by the Council (Spring European Council, March 2007[17]) and European Parliament (the Thomsen report adopted 25th September 2007[18]).

There is common support for a 20% binding target for renewable energy and a 10% binding target for biofuels.

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[16] COM(2006) 848.

[17] Council Conclusions 7224/07.

[18] Report A6-0287/2007.

In describing how this approach would be implemented, the Commission identified the need for the biofuel target to be set at the same level in each Member State; for the overall energy target to be set at different levels for different Member States; for administrative and market barriers to the development of renewable energy to be removed; for the creation of a biofuel sustainability regime (including advantages for second-generation); and for changes to fuel standards to allow higher biofuel blends.

The Spring European Council endorsed the need for the overall target to be differentiated between Member States; highlighted the importance of biofuel sustainability, amended fuel standards and second-generation biofuels; and pointed to the need to investigate "cross border and EU wide synergies for reaching the overall renewable energy target" (i.e. trade, either physical or virtual, in renewable energy).

Parliament also broadly endorsed the approach and referred specifically to the use of final energy consumption for target measurement.

In the light of this, the development of legislation on renewable energy raises a number of design issues. First, it is necessary to decide how progress towards national and European targets will be measured – in other words, how the contribution of renewable energy will be accounted for. Next, the 20% target needs to be shared between Member States. Then, it is necessary to consider how flexibility can be introduced to help Member states achieve their targets in a cost effective manner. These design choices will establish the overall architecture of the Directive – a system of national targets and a set of mechanisms through which Member States can fulfil them. In addition, the Directive should include measures to facilitate the achievement of the targets, in particular in relation to:

- administrative and market barriers to renewable energy;
- the sustainability of biofuels (including support for second-generation biofuels); and
- the blending of biofuels in conventional fuel.

The policy options assessed are set out in the sections below.

4.3.1. Accounting method

Three accounting methods are compared:

<u>Primary energy consumption (the "Eurostat method")</u>

Primary energy is defined as the first commodity or raw material for which multiple energy uses are practical. Thus, primary energy measures energy <u>inputs</u> to conversion processes such as electricity generation. When non-thermal renewable energy sources such as wind and hydropower are used for electricity generation, the arbitrary assumption is made that the energy input is equal to the energy output. The current 12% target for the share of renewable energy in 2010 is based on this definition.

<u>Primary energy consumption with substitution</u>

Under the substitution method, non thermal electricity (hydro, wind, tide/wave, photovoltaic) is valued in terms of the fuel input required by a hypothetical conventional thermal power plant. The other energy sources are valued in the same way as in the Eurostat method[19].

Final energy consumption

Final energy consumption is defined as the energy commodities delivered to final consumers for energy purposes (heat and power). It is lower than primary energy because it is measured after "losses" in producing derived energy commodities (transformation losses in heat and power stations); but as gross final energy consumption, it is measured before losses in transmission and distribution and includes consumption of energy by the electricity and heat industry itself.

Directive 2001/77/EC lays down national objectives for the share of renewable energy in electricity generation in 2010. These are defined as the national production/import of electricity from renewable energy sources divided by the gross national electricity consumption (final consumption before transmission and distribution losses and the consumption of the energy sector).

Directive 2003/30/EC lays down national objectives for the share of renewable energy in transport petrol and diesel in 2010. These are defined in terms of renewable fuels placed on the market. Again, this definition resembles final energy consumption rather than primary energy.

4.3.2. Sharing the 20% renewables target among Member States

Following the Commission's proposal, the European Council endorsed establishing a binding 20% renewable energy target and a 10% biofuels target for 2020. The Council requested that the national targets be set "with a view to sharing efforts and benefits fairly and equitably among all Member States, taking into account different national circumstances, starting points and potentials". Two options for sharing the target between Member States that try to address this request are compared:

- sharing on the basis of Member States' national resource potential. Each Member States renewable energy resources and costs are estimated, together with the estimate of total energy consumption for 2020.

- sharing on the basis of a flat-rate increase in the share of renewable energy (measured in percentage points) in each Member State weighted by GDP. (The EU has to increase its renewable energy share by 11.5% (20% in 2020 - 8.5% today). This is achieved in the following approach:

1. The share of renewable energy in 2005 (the base year for all calculations in the package) is modulated to reflect national starting points and efforts already made: Those Member States whose growth in renewable energy was more than 2% over 2001-2005 receive a reduction of a third of that growth from the 2005 base year share.

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[19] To be precise, this defines the partial substitution method. Full substitution would use a hypothetical power plant to value the contribution of all fuels for electricity generation.

2. 5.5% is added to the modulated 2005 share of renewable energy for every Member State. This results in 76.1 extra mtoe in 2020, needing a further 76.1 mtoe to reach 20% of expected 2020 final energy consumption 254.1 mtoe).

3. This remaining effort (0.16 toe for each person in the EU) is weighted by a GDP/capita index, to reflect different levels of wealth across Member States, and multiplied by each Member State's population

4. These two elements are added together to derive the full renewable energy share of total final energy consumption in 2020.

5. A cap is placed to ensure that the target is not 50% or more of any Member State's energy mix.

(see Annex 6 for the calculations themselves).

4.3.3. Improving the guarantees of origin regime

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.

Article 5 of the Directive introduces a minimum set of requirements for the GO. The GO must specify the source, date and place of production in a reliable manner; it should be mutually recognised by all Member States exclusively as proof of renewably sourced electricity, and it should be reliable and accurate. The GO can be used for a number of purposes, including claiming subsidy (a feed in tariff or green certificate payment), supporting electricity bill energy mix "disclosure"[20], and proving compliance with national renewable energy obligations. However, these applications are voluntary. Under the Directive, producers of renewable electricity may request certification that the electricity they produce is from renewable energy sources. Furthermore, whilst the Directive allows the GOs traded together with underlying electricity (physical trade) to count towards the indicative national renewable electricity targets, no Member States have so far agreed to allow such trade. Any transfer of GO between Member States for national target purposes requires an agreement between the two Member States[21].

Currently, some Member States use GOs for disclosure purposes; others simply recommend such practices; others still use them to qualify for national support schemes. These differing national perspectives has lead to different specifications for GOs in Member States.

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[20] In accordance with Article 3(6) of Directive 2003/54/EC, Member States are required to implement a scheme for the disclose of the fuel mix.

[21] A clarification on the use of traded GOs for target compliance was introduced in the Communication from the Commission to the European Council and the European Parliament "The share of renewable energy in the EU" - COM(2004) 366.

Other renewable energy sectors are not currently covered by the GO regime, however GOs are currently being developed for high-efficiency CHP[22].

The following options for improving the regime are assessed:

- Keeping the current GO system. This option implies that the EU would not go beyond existing efforts in facilitating trade in renewable electricity and consumer transparency between renewable and non-renewable electricity with the help of GOs, as contained in Article 5 of Directive 2001/77/EC.

- Standardising guarantees of origin. This option entails strengthening the regulatory framework of the GO, by introducing new requirements in order to make the GO more reliable and accurate as a transferable instrument.

4.3.4. Virtual trade in renewable energy

Under existing Community legislation, physical trade in electricity, verified as renewable by guarantees of origin, can count towards another Member State's target when the two Member States agree. However "virtual" trade in the guarantee of origin alone is not permitted to count towards the targets.

Trade can be a way of reducing compliance costs, particularly if national targets are set on the basis of a methodology in which national resource potential plays a limited role or no role at all. To facilitate trade the creation of a market for guarantees of origin for target compliance should be considered. The following options for the introduction of virtual trade are assessed:

a) Status quo: The current system of physical trade with GOs for target compliance with mutual agreement would continue and GOs traded "virtually" would not count towards the targets.

b) Opening of virtual trade using GOs, where Member States would be free to have trade in GOs for target compliance, but could limit imports and exports at their discretion. (voluntary, CDM-like trade)

c) Opening of virtual trade using GOs where Member States would be free to have trade in GOs for target compliance, could limit imports but not exports; producers would be free to sell GOs on the European market. (export trade).

d) Opening of virtual trade using GOs where Member States could not limit exports or imports. Such full opening could be implemented immediately (as soon as the Directive comes into force), after a transition period (after a certain date) or in a phased manner (such as opening to a gradually increasing proportion of the market (for example, 10% in 2011, 20% in 2012 and so on, rising to 100% in 2020). (full trade).

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[22] Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.

e) Whilst GOs were created for the electricity sector, the scope of trade in GOs could also be extended, adding the EU centralised heating sector, adding the entire EU renewable energy sector and including renewable energy produced in third countries.

In each case, if the scope of virtual trade is to be extended beyond the EU electricity sector, it should be noted that the system of GOs will have to be extended in parallel.

4.3.5. Monitoring with national action plans

It can be difficult to monitor requirements of Member States over a long period of time or with quite broad goals that require specific actions. For that reason, it is not uncommon to request national action plans in EU legislation[23], which allow the Member State to clearly demonstrate compliance with the law. The option of using national action plans to monitor compliance would include Member States providing information on:

a) national sectoral targets for 2020 for the share of renewable energy in the sectors of electricity; heating and cooling; and transport petrol and diesel;

b) the planned national development path for renewable energy between 2010 and 2020;

c) the measures to be taken to achieve these targets;

d) Developments in the availability and use of biomass resources for energy purposes.

In addition, the question of whether the sectoral targets are binding and whether binding interim targets are necessary also needs assessment.

4.3.6. Reducing administrative, grid and market barriers

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, attractive landscape development, public health and protection of the 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. Public consultations and studies[24] launched by the Commission show that existing administrative procedures are hampering the development of renewable heating and cooling as well as electricity. Reducing administrative burdens is also an important part of the EU's Lisbon Strategy and underlies the Commission's commitment to Better Regulation as part of its "Growth and Jobs" strategy.

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[23] Examples include the Energy Efficiency Action Plans required under Directive 2006/32/EC, National Action Plans on Social Inclusion, agreed under the Common Objectives.

[24] OPTRES report "Analysis of barriers for the development of electricity generation from renewable energy sources in the EU25", May 2006, under the OPTRES project, contract No.: EIE/04/073/S07.38567 (www.optres.fhg.de); Progress report, 2007 "Identification of administrative and grid barriers to the promotion of electricity from Renewable Energy Sources http://ec.europa.eu/energy/res/consultation/admin_barriers_en.htm, and MVV Consulting, June 2007: "Heating and cooling from renewable energies: cost of national policies and administrative barriers" http://ec.europa.eu/energy/res/sectors/heat_from_res_en.htm.

In addition, project developers face different grid-related barriers. These are for a large part related to insufficient grid capacity available, non-objective and non-transparent procedures for grid connection, high grid connection costs as well as long lead times to obtain authorisation for grid connections.

Existing legislation on the promotion of renewable electricity in the EU (Directive 2001/77/EC) requires Member States to evaluate the existing legislative and regulatory framework with a view to reducing the regulatory and non-regulatory barriers to the increase in green electricity production, streamlining and expediting procedures at the appropriate administrative level, and to ensure that the rules are objective, transparent and non-discriminatory. There is no specific obligation on Member States to carry out the necessary reforms. The obligation on member States is to report on the evaluation referred to above, and any actions taken.

On the issue of grid access, Member States are required to ensure that transmission and distribution of renewable electricity is guaranteed, and may also provide priority access to the grid for renewable electricity. However, such access is contingent on the reliability and safety of the grid. Member States are also required to put in place transparent, objective and non-discriminatory rules for the sharing and bearing of various grid investment costs as well as ensure that the charging of transmission and distribution fees do not discriminate against renewable electricity. Even with transparent pricing, the high cost of connecting to the grid is in many cases prohibiting the development of small projects.

Certain information failures of the market also cause non-price market barriers to the growth of renewable energy. Similar to energy efficiency measures, inadequate information on the part of both professionals (architects, equipment installers etc.) and consumers due to the complexity of the issues or fast changing nature of the equipment can result in suboptimal investment in renewable energy.

Specific actions to tackle these problems have been recommended in the Commission report on the support of electricity from renewable energy sources[25] and related studies (OPTRES, 2006 and PROGRESS, 2007) and public consultations in both renewable electricity and heating and cooling (JRC, 2007)[26].

Based on these reports, studies and public consultations, the following options are assessed:

Do nothing more.

Strengthening requirements to simplify administrative procedures. Under this option the existing provision on the simplification of administrative procedures of Directive 2001/77/EC would be strengthened by introducing an obligation on Member States ensure that any regulatory barriers resulting from authorisation, certification and licensing procedures are proportionate and necessary.

The requirements would be extended to cover the heating and cooling sector.

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[25] Communication from the Commission "The support of electricity from renewable energy sources - COM(2005) 627.

[26] JRC report, 2006 "Results of the public consultation on an initiative on heating and cooling from renewables": http://ec.europa.eu/energy/res/consultation/index_en.htm.

Related to grid access, this option entails requiring Member States to take necessary steps to develop grid infrastructure to accommodate the further development of renewable electricity.

More precise and specific options that help achieve these general goals are also examined:

Establishing a one-stop authorisation agency at national level.

Guidelines with clear attribution of responsibilities between national, regional and local authorities for authorisation procedures.

Providing for automatic approval of planning and permit applications where authorisation body has not responded within the set time limits.

Establishing lighter authorisation procedures for smaller projects.

Requiring Member States to establish spatial planning mechanisms, whereby regions and municipalities assign locations for different renewable energies.

Requiring Member States to review with the aim of improving the framework or rules for bearing and sharing of grid investment costs that are necessary to integrate new renewable electricity producers into the interconnected grid.

Laying down mutual recognition of certification for renewable energy and heating and cooling equipment.

Requiring Member States to institute precise deadlines for planning approval

Requiring renewable energy use in new and renovated buildings

Requiring Member States to provide accurate information and training on the availability of different types of equipment

Consideration was also given to the option of including public procurement measures in the draft Directive. Public procurement can play a significant role in encouraging the use of renewable energy sources. Directive 2004/18/EC[27] on public procurement enables Member States to base contract award criteria on environmental characteristics. However, many public tenders contain references to the environment which are not well defined and therefore do not result in a greener purchase. The TAKE-5 report[28] on Green Public Procurement in the EU-25 highlights that only seven EU Member States are currently implementing more elements of green public procurement than the others. This means that they consistently have more tenders with green criteria than the rest within the EU-25. One of the main reasons for unclear references is the lack of training in this area. In a market worth over €1.500 billion - representing over 16% of total EU GDP - EU public procurement Directives have reduced the prices paid by public authorities for goods and services by more than 30%. Further clarifications and clear definitions and specific award criteria for the use of renewable energy sources in public procurement could therefore be encouraged.

Whilst this problem is important, preliminary examination showed that it is not appropriate to include green public procurement rules in the new Directive on renewable energy sources.

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[27] Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

[28] Bouwer M, Jonk M, Berman T, Bersani R, Lusser H, Nappa V, Nissinen A, Parikka K, Szuppinger P and Viganò C, 2006. Green Public Procurement in Europe 2006 – Conclusions and recommendations. Virage Milieu & Management bv, http://europa.eu.int/comm/environment/gpp

Instead, the proper implementation of Directive 2004/18/EC and the updating of the handbook[29] produced by the European Commission to overcome the lack of knowledge and to set the right environmental criteria in tender documents, should be achieved. Therefore, this option will not be examined further in this impact assessment.

4.3.7. Achieving a 10% share of biofuels

In the renewable energy roadmap, the Commission assessed the impact of the achievement of a 10% share of biofuels in transport and 2020 and concluded by recommending this option.

This approach was endorsed in the conclusions of the spring European Council [and in the European Parliament's vote on the Thomsen report].

It is not the function of the present impact assessment to repeat the investigation of whether such a target is appropriate. The issue to be addressed here is how to design a legislative proposal that will ensure that the 10% target is achieved in an optimal way, with particular focus on:

- criteria for the sustainability of biofuels;
- tools to promote the development of second-generation biofuels and other especially desirable biofuels;
- ensuring that fuel standards are compatible with the efficient achievement of the 10% target.

Other policy areas of importance in this context, such as trade policy, are not covered by this impact assessment and will be subject to further work as well as initiatives from the Commission. The Directive will provide for regular monitoring of the EU market for biofuels with a view, *inter alia*, to the Commission proposing relevant trade measures as appropriate.

Concerning the **sustainability of biofuels**, the following questions are assessed:

i) What aspects of the impact of producing biofuels should sustainability criteria cover?

ii) How should the impact of producing biofuels be measured?

iii) What should be the required minimum level of performance?

iv) What should be the consequences of failing to meet the required minimum level of performance?

v) How should performance be verified?

Concerning **the promotion of especially desirable biofuels**, the following questions are assessed:

i) How should the set of especially desirable biofuels be defined?

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[29] European Commission, 2004, "Buying Green: A guide book to environmental public procurement".

ii) What bonus should these biofuels receive?

Concerning **fuel standards**, the following questions are assessed:

(i) Is a change to a 10% blend of biodiesel in diesel technically feasible?

(ii) Is a change to a 10% blend of biodiesel in diesel needed?

(iii) What instrument should be used to implement such a change?

4.3.8. State aid implications of binding targets for renewable energy

Chapter 6 concludes with an analysis of how the introduction of binding targets for renewable energy in general and for biofuels in particular will affect Member States' ability to give State aid in this sector.

5. ANALYSIS OF IMPACTS

5.1. Modelling tools used Options for implementing the renewable energy objective Relationship between GHG and the renewables objective

A combination of the PRIMES and GAINS model was used to assess combinations of scenarios that meet both the 20% GHG reduction target and the 20% renewables target across different sectors and Member States. Costs and benefits can be compared to the new PRIMES baseline (2007). These models give detailed representation of the energy system and mitigation options and technologies in all sectors and for all GHGs but do not address the macro-economic interactions between the economic sectors.

GEM E3 was used to assess the overall macroeconomic impacts and the indirect effect between sectors of the GHG reduction target. It was not possible to use it to assess the RES target It was used to asses the impact of auctioning versus continued grandfathering approaches for allocation of allowances, different effort sharing approaches as well as overall impacts of implementing the unilateral and multilateral targets, respectively.

The POLES model was used to examine the impacts of the 20 and the 30% reduction in GHGs, with detailed representation of the energy systems on a global scale.

The PACE model was used to assess the specific impacts the sector specific impacts on energy-intensive industries of meeting the GHG reduction and growth in the share of renewable electricity.

The PRIMES model simulates the European energy system and markets on a country-by-country basis and provides detailed results about energy balances, CO2 emissions, investment, energy technology penetration, prices and costs at 5-year intervals over a time period from 2000 to 2030. The current version of the model PRIMES include extensive representation of power generation technologies and incorporates detailed information about future power plants enabled with carbon capture and geological sequestration. The model establishes a complete linkage between supply and demand for energy with endogenous price formation within the EU. This allows CO2 and renewable policies to be assessed ensuring consistency of technology deployment within market equilibrium in the energy system taking into account feed-back impacts of energy prices on energy demand. The PRIMES 2007 energy baseline, developed with Member States, reflects current trends and policies and their impact on the energy system. In the new PRIMES baseline, primary energy demand rises by 9% to 2030; annual energy intensity improves by 1.8 % and energy import dependency rises from 50% to 67%. By 2020 the renewable energy share would grow from 8.4% to 12.5%, and CO_2 emissions would rise by 5% above 1990 levels. Scenarios in PRIMES to achieve the GHG emission reduction and RES target are always applied on the basis of this baseline. It assumes 2.4% annual economic growth, oil prices rising from \$55/barrel to \$61/barrel in 2020 (in 2005 values) and CO_2 prices rising from €20/tCO_2 in 2010 to €22/tCO_2 in 2020. For a more detailed outline of the baseline see Annex 1. With respect to the transferability of guarantees of origin, PRIMES scenarios are assuming full trade, which is an overestimation with respect to the proposed regime. (see also chapter 6.4).

On top of PRIMES, the GAINS model was used to assess the reduction options for non-CO2 emissions. GAINS (Greenhouse and Air pollution Interactions and Synergies) can assess the potential and costs for further mitigation of the non-CO_2 greenhouse emissions in each of the 27 EU Member States beyond currently agreed policies. It addresses all non-CO_2 gases included in the Kyoto Protocol: methane (CH_4), nitrous oxide (N_2O), and the three F-gases hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). GAINS projects future emissions and assesses the remaining mitigation potentials and costs. A baseline projection similar to the PRIMES 2007 baseline quantifies the impacts of economic development and currently agreed mitigation policies. The analysis uses national projections made for the revision of the NEC Directive. Furthermore, the analysis derives cost curves that rank, for each Member State and non-CO_2 greenhouse gas, remaining mitigation measures by increasing marginal mitigation costs.

GEM-E3 is a general equilibrium model that covers economic, energy and environmental aspects. Both the global and European version of the model were used to assess the macroeconomic and welfare implications of:

1. of various assumption on the allocation targets;

2. the introduction of a carbon value in the economy (both through auctioning and grandfathering);

3. access to JI/CDM type of mechanisms;

4. and the recycling of auctioning revenues.

For this exercise the GEM-E3 Europe database was updated with the latest EUROSTAT Input Output tables, i.e. for the year 2000. Bulgaria and Romania were added. Three Member States are not included in the GEM-E3 Europe model, i.e. Cyprus, Luxembourg and Malta. The model only considers CO2 emissions from energy.

POLES is a long-term energy model for the world that represents 47 regions. It models demand and supply in the energy sector as well as greenhouse gas emissions and can therefore analyze the implication of international agreements on greenhouse gases. It was used to assess the economic implications and impacts on the energy system of:

- a 20% unilateral commitment to reduce greenhouse gas emissions in 2020;

– a 30% multilateral target in greenhouse gas reductions in 2020 in an international context

The PACE model is a general equilibrium model similar to GEM-E3 but it includes a more detailed representation of electricity production technologies. The coverage of the EU27 Member States is more aggregated than GEM-E3. It was used to examine the general and sector specific impacts of energy-intensive industries exposed to international competition of meeting the GHG target and a 30% renewable electricity target.

Whilst internally coherent as used throughout this impact assessment, it should be recalled that economic modelling to 2020 is a simplification of the economic processes at work in every part of each Member State's economy over the next twelve years. Assumptions regarding resource potential, cost trends, growth rates etc. often differ, and the ability of models to examine detailed microeconomic changes is necessarily an abstraction from reality. For this reason the actual costs and technology pathways will vary.

5.2. Relationship between GHG and the renewables objective

GHG and RES targets and the policies to achieve them have an influence on each other. To assess these interactions three scenario's where developed and assessed with the PRIMES/GAINS model:

- RES target is achieved in a cost effective manner but without any specific policies to achieve the GHG commitment.

- GHG commitment of 20% is achieved in a cost effective manner but without any specific policies to achieve the RES target.

- Both the RES and the GHG commitment are achieved in a cost effective manner.

Comparing the results of these three runs allows for the assessment of the impact of both targets and policy instruments to achieve them and the impacts on each other. The table below gives an overview of the key results for the EU 27:

Table 1 Impact of stand alone and combined RES and GHG policies on the share of renewables, and CO2 and GHG emissions in 2020, without access to JI/CDM

	2020		
	RES share final energy consumption	Compared to 1990	
		CO2 emissions from energy	Total GHG emissions
Baseline projections	12.5%	5.1%	-1.5%
20% RES achieved	20.0%	-5.8%	-9.3%
20% GHG achieved	15.8%	-15.8%	-20.0%
20% RES and GHG achieved	20.0%	-16.7%	-20.0%

Source: Primes/Gains

The table shows clearly that stand alone RES policies have a significant impact on the reduction of GHG emissions. Conversely, stand-alone GHG policies do increase the deployment of renewables, even though the effect is less pronounced. Renewables policies alone will not be sufficient to meet GHG commitments even though emissions are reduced by 10 % compared to baseline. GHG policies alone will not meet the RES targets. One needs to combine both GHG and RES policies in order to reach both targets.

One particular impact of combining these two policies is likely to be a shift towards more energy related CO2 reductions, compared to achieving the GHG target only. Renewables policies in combination with GHG policies will give additional incentives to deploy more renewables on top of what would be done in a 'GHG policy only' case, and thus reducing more CO2 emissions in the energy sector.

In this context, it must be highlighted that the policy instruments to achieve these commitments have an impact on each other. Putting a renewables policy in place lowers the carbon price necessary to deliver the GHG reduction commitment. The scenarios in **Table 1** require a carbon price of 49 €/t CO_2[30] to achieve the 20% GHG reduction commitment if no renewables policies are put in place. But when renewables policies are introduced to achieve the RES target, a carbon price at 39 €/ t CO_2 would achieve the same GHG reduction target. Similarly the RES incentive[31] to achieve the RES 20% target, lowers from 56 €/MWh to 45 €/MWh with the deployment of GHG policies to achieve the GHG reduction commitment.

Conclusions

1. There is a clear interdependency between both targets.

2. Therefore the impact assessment needs to evaluate both targets in a consistent manner and to analyse the interplay of both targets, their related policy instruments and their combined environmental, energy, economic and social impacts.

3. Equally, targets at each MS state level need to be assessed in a consistent manner.

4. There is need for both GHG policies and RES policies, if both targets are to be met simultaneously.

5. Policy instruments for RES and GHG emissions need to be set up that are mutually reinforcing and compatible ensuring a cost efficient overall outcome.

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[30] The carbon price referred to is the Marginal Abatement Cost to reduce the last ton of CO_2 equivalent emissions to achieve the GHG reduction target according to the PRIMES/GAINS model.

[31] The Renewables value is the incentive/support introduced in the scenario in order for the last Megawatt of RES to be produced to achieve the 20% RES target according to the PRIMES/GAINS model.

5.3. The independent EU GHG reduction commitment of at least 20% by 2020 compared to 1990 levels

5.3.1. The EU GHG emission reduction target by 2020: emissions covered, required effort and base year

The EU15 and all Member States of the EU 27 are committed under the Kyoto Protocol to certain levels of quantified emission limitations or reduction commitments. These cover the emissions of the gasses and sectors listed in Annex A of the Kyoto Protocol. These activities do not cover greenhouse gases not controlled by the Montreal Protocol, from aviation and marine bunker fuels.

Unfortunately, aviation and marine bunker fuels also contribute to climate change. In the period 1990 to 2005 emissions bunker fuels in the EU27 have increased by 63%, whereby emissions from aviation have increased faster than those from marine bunker fuels with respectively and increase of 91% and 46% over this period. Since bunker fuels are not yet covered by the Kyoto Protocol, this growth currently has no legal implications. Nonetheless, this does not reduce its environmental implications which will have to be addressed as part of any effective forward-looking climate policy.

Concerning the emissions from aviation, the Commission adopted on 20 December 2006 a proposal for amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community. To be consistent with this existing policy proposal, that is at present discussed in the European Parliament and Council under the co-decision procedure, the emissions from aviation bunker fuels will also be included in this impact assessment. The eventual outcome of how aviation will be included in the EU ETS is still uncertain. It is assumed for the analysis as presented in this Impact Assessment that all aviation from flights outbound of the EU is included, and thus including all intra EU flights and all flights leaving the EU but not those incoming from outside the EU. To achieve the independent 20% GHG reduction commitment all emissions from outbound flights from the EU are thus included. If Council and the European Parliament confirm the scope of the aviation proposal proposed by the Commission then inbound flights from outside the EU would be included in the EU ETS unless third countries took equivalent measures. If they did not take equivalent measures, this could increase the demand for allowances in the EU ETS compared to what was calculated in this Impact Assessment. Third countries could for instance have airlines offset their outbound emissions through JI/CDM credits, which would both be quantitatively equivalent and of particular interest to countries that generate these credits. If this did not happen then, there could be extra demand which could thus actually lead to a higher reduction in the sectors assessed in this impact assessment.

This impact assessment does not include the emissions from marine bunker fuels given that at present no specific policies are yet defined to address these emissions. Of course, when such policies are elaborated, it will need to be assessed how they relate to the EU's independent GHG reduction commitment of -20% and the -30% reduction target when an international agreement on future climate change policies is reached.

The analysis in this impact assessment neither includes the development of emissions and removals from the land-use, land-use change and forestry sector (LULUCF). The inherent features of the LULUCF sector (, namely time required for public policies introduced in the sector to deliver expected results, limited anthropogenic margin of manoeuvre in a sector that is under heavy influence of natural phenomena and variability, multiplicity of small stakeholders involved, sector at the centre of numerous environmental, economical and social policies) have been described at length in the context of designing policies to mitigate climate change in this sector.

The Kyoto Protocol through its Article 3.3 and 3.4 made a first attempt to address the LULUCF sector in the context of climate change policies. It is widely acknowledged that the current Kyoto Protocol regime for LULUCF has still scope for improvement. Current rules only partially address the sector (e.g. no accounting for harvested wood products). For those activities covered different accounting rules apply (e.g. Afforestation-Reforestation-Deforestation, Forest Management and Cropland). For certain of these activities countries can opt to include and account for them or not for the period 2008-2012. These rules are likely to be further developed for the period after 2012.

Building on the reporting of projections by Member States, estimates on the scope of mitigation through this sector can be made but these are substantially influenced by the choice of activities that will be included after 2012 as well as the future accounting rules that will be applied. Therefore estimates of what the contribution of the LULUCF sector could be by 2020 are still very uncertain.

National mitigation policies specifically developed for the LULUCF sector have been limited in Member States. Therefore existing projections often express baseline scenarios. The extent to which these projections will be influenced due to additional policies to be put in place by the year 2020, is still unclear.

Given all these elements, a too high uncertainty remains on the level of GHG mitigation that can be expected from the LULUCF sector in the EU by 2020. Therefore it was opted not to include the LULUCF sector in this Impact Assessment.

This impact assessment will address the required reduction within the EU27 to achieve the EU's independent GHG reduction commitment by 2020 of -20% and the -30% reduction target when an international agreement on future climate change policies is reached, compared to 1990 emissions. This analysis addresses the required reductions based on the emission levels of the year for which the most updated data is available, i.e. 2005. This is also the first year for which detailed emission information for the EU-ETS is available. This is equally important and necessary from the perspective of policy design choices indicated later in this impact assessment, in particular the need to split efforts in EU ETS and non EU ETS sectors. 2005 is indeed the first year for which a full reliable and verified data set for these sectors is available.

In 2005, the total CO_2 Equivalent Emissions without LULUCF, as reported to the UNFCCC[32], for the EU 27 was 7.9% below 1990 levels. Including emissions from aviation bunker fuels this reduction is lower, at -6.8% below 1990 levels. This impact assessment will assume that emissions, including from aviation bunker fuels (outbound flights), have to be reduce a further -13.2% compared to 1990 levels to achieve the -20% independent reduction target. Expressed

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[32] Where possible data for Cyprus and Malta are included. For Cyprus these are data reported under the EU monitoring mechanism decision (Decision 280/2004). Malta did not provide GHG emission estimates for 2005, therefore the data used for this calculation is based on gap filling.

as a reduction compared to 2005 emission levels this is equal to a reduction of -14.2% compared to 2005.

Conclusion

1. This impact assessment includes emissions from aviation (intra EU and outbound). It does not include marine bunker fuels and LULUCF.

2. 2005 is the preferred base year for the analysis as it gives the most recent reliable and verified emission data, for EU ETS and non EU ETS sectors separately.

3. As a result the 20% reduction target for GHG emissions compared to 1990, results in a required effort of -14.2% compared to 2005 for the emissions covered under this analysis.

5.3.2. GHG reduction commitment, relationship with cap setting under the EU ETS

The EU ETS sector with its present scope and the inclusion of emission from aviation, represents more than 40% of all GHG emissions in the EU. This share would increase if more sectors and/or GHGs are to be included in the EU ETS. Future allocation will need to ensure that those sectors covered by the EU ETS contribute efficiently to the achievement of the independent EU GHG reduction target.

At present Member States propose through their NAPs the total GHG emission cap for their ETS sectors and the individual allocation to the different installations, and the Commission assesses these. As such, this process implicitly determines the GHG emission cap for Member States' sectors not covered by the EU ETS and the amount of JI/CDM credits that they will acquire to comply with their emission reduction commitments and that their industries are allowed to use for compliance under the EU ETS. The methodology on how to determine the NAPs is of significant importance when considering how to share the efforts to achieve the independent EU GHG reduction commitment of -20%.

The impact assessment for the proposal to amend Directive 2003/87/EC has identified several problems with the existing NAP procedure and the cap setting process. For instance national caps were proposed that were higher than environmentally efficient levels, there is a lack of a level playing field at sector and installation level, there is too much uncertainty and lack of predictability in the allocation process, overall transparency can be improved and the process involves a high administrative burden and cost for Member States and the Commission.

The same impact assessment 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, to be defined in the Directive 2003/87/EC, ensuring as such effectiveness in setting the appropriate cap, ensuring better predictability, simplicity and transparency, guaranteeing international credibility, reducing the administrative burden and achieving the appropriate contribution of the EU ETS to achieving the 20% GHG reduction with clear procedures for adapting to a 30% reduction target when an international agreement on future climate change policies is reached.

Retaining this option for a clear definition ex-ante of the overall emissions' cap in the EU ETS would require that the independent EU GHG reduction commitment of at least 20% is first distributed between the EU ETS and those sectors not covered by the EU ETS. To the extent allowances are continued to be given out for free, the EU ETS cap needs to be further 'distributed' to the different sectors within the EU ETS that would receive free allocation. The right to auction allowances will need to be distributed among Member States. For those sectors that are not covered by the EU ETS, the commitment will then have to be distributed between Member States. As such an effort sharing agreement for the post-2012 commitment would have to focus only on these sectors that are not covered by the EU ETS sectors.

Conclusion

1. One EU-wide ETS cap needs to be defined. Within the EU-ETS, the efforts would then be distributed through more harmonised allocation rules. For those allowances that will be auctioned, the amount of allowances that each country is allowed to auction needs to be defined (sharing of auctioning rights among Member States).

2. Therefore the EU GHG reduction commitment needs to be differentiated in a reduction effort for the EU ETS and a reduction effort for those sectors not covered by the EU ETS.

3. Effort sharing between Member States is limited to these non EU ETS sectors.

5.3.3. Defining the effort for EU ETS and non EU ETS sectors

The impact assessment for the proposal to amend Directive 2003/87/EC looks in greater detail at different methods to set the EU ETS cap. This assessment underlines that there is a strong case for a cost efficient approach, considering the overall cost levels that will be required in the medium and long term, both to achieve emissions reductions in the order of up to 80% by 2050 and to adapt to the effects of climate change.

A cost-effective approach equalises the marginal abatement costs between the trading and non-trading sectors and ensures that the overall GHG reduction commitment is achieved cost-effectively and that all sectors contribute equally to this commitment. The reductions projected at this marginal abatement cost could also define the emission cap for the trading and non-trading sectors.

The PRIMES/GAINS model was used to define a cost-effective division for the greenhouse gas reduction commitment between the EU ETS and Non ETS sectors[33]. This assessment includes the cost efficient achievement of the 20% RES target and it is assumed that the GHG reduction target is effectively achieved in 2020, thus assuming no access to JI/CDM nor banking any surpluses from previous years.

The table below shows the results for a cost-effective division of emission reduction efforts between the ETS and non-ETS sector by PRIMES/GAINS that meets both the GHG and the RES 20% commitments efficiently. The results are given compared to 2005. The necessary carbon value is equal to around 40 € per ton $CO_{2\text{-eq.}}$ without action outside the EU via JI/CDM.

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[33] See Annex 2 for more detail on the sectors assumed to be included in the EU ETS in the PRIMES/GAINS scenarios and how differences between total emissions in the EU ETS as represented in Primes and actual reported emissions in the EU ETS are taken into account. Also note that the required total reduction is a bit higher, at -14.4%, in the PRIMES/GAINS modelling than as required when comparing to UNFCCC reported data. This is due to the use of different data sets. For instance CO_2 emissions in PRIMES are calculated using EUROSTAT data.

Table 2: reduction in EU ETS (including outbound aviation) and–non EU ETS sectors to meet the 20% reduction in a cost-effective way

ALL GHG, carbon value = 40 € per ton $CO_{2\text{-eq}}$		
% reduction in 2020 compared to 2005.		
-14.4 %		
EU ETS (incl. aviation)	**Non EU ETS**	
-18 %	-12%	
	CO2	Non-CO2
	-7%	-21.5%

Source: Primes/Gains.

In this table, aviation (outbound) is included in the EU ETS. Emissions in the existing (non-aviation) EU ETS sectors are projected to decrease more, i.e. by 21.3% compared to 2005. .

A large part of the cost-reductions are expected to be possible in the non-CO2 gasses and the EU ETS. Overall EU ETS sectors would have to reduce relatively more than the non-ETS. To achieve the GHG reduction commitments cost effectively, non-CO2 GHGs are expected to have to be around 21.5% below their 2005 levels in 2020, while CO2 emissions in sectors not covered by the EU ETS (transport, heating in buildings) might only need to reduce emissions by 7% compared to 2005.

Conclusion

1. 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:

- The ETS sector, including aviation, would see emissions reduce with around -18% compared to 2005.

- The ETS sector, excluding aviation, would see emissions reduce with around -21% compared to 2005.

- The Non- ETS sector would see emissions reduce with around -12% compared to 2005.

2. The expected carbon value to achieve this commitment is around 40 € per ton $CO_{2\text{-eq.}}$ without action outside the EU via JI/CDM and with policies in place to ensure that the 20% RES target is achieved .

5.3.4. Sharing of effort among Member States in the sectors not covered by the EU ETS

Upon agreeing on an independent commitment, the European Council agreed that a differentiated approach would have to take into account fairness and national cicumstances.

In most of the sectors not covered by the EU ETS (e.g. transport except aviation, housing & services, heating, non CO2 GHG emissions) climate change policies are to a large extent Member States' competence for subsidiarity reasons. If one wants to differentiate between Member States for fairness reasons then it makes sense to do so in the non-ETS sectors, sectors where climate change related measures have less impact on the internal market and on competitiveness across borders and where Member States have more freedom and competence to act. However, EU-wide measures (such as product standards for cars and appliances) will supplement Member States efforts to achieve such national targets. Considering, for instance, the earlier described relationship between GHG and RES policies, the allocation methodology should take into account the impact of RES deployment.

To give some insights in potential differentiated approaches, several examples where assessed:

(a) A cost-efficient scenario at the level of the whole EU

(b) A scenario that would equalise emissions per capita in the sectors not covered in the EU ETS by 2020

(c) A scenario that would result in an equal reduction in the sectors not covered by the EU ETS in all Member States compared to 2005 levels.

(d) A scenario that would differentiate the reduction targets in the sectors not covered by the EU ETS depending on the relative GDP/Capita of the different Member States

5.3.4.1. Cost-Efficiency

The cost-efficient policy case simulates least cost reduction for the whole EU in the non-ETS sectors through equalisation of the carbon value across all sectors (including EU ETS) and Member States, assuming cost efficient policies to achieve the 20% RES target within the EU.

A cost efficient allocation that achieves both the GHG and RES targets is expected to lead to substantially different impacts across the EU. **Table 3** represents the total costs of increased energy system costs and mitigation costs for the non-CO2 gasses in both the EU ETS and sectors not covered by the EU ETS while achieving both GHG and RES targets. It does not include co-benefits such as for instance benefits from reduced air pollution (see chapter 5.3.9.1). These costs are the net increase in the total sum of (annualized) investment costs and changes in energy costs (Operating & maintenances and fuel costs). These are increased cost estimates but do not constitute a net loss to GDP.

The carbon value would be equal to around 39 € per ton $CO_{2\text{-eq.}}$ without action outside the EU via JI/CDM and when the additional effort to meet the RES target is met through additional cost efficient policies.

All Member States with a GDP per capita below the EU average, with the exception of Spain, Cyprus and Malta, are expected to have an energy cost increase as percentage of GDP of at least 50% higher (i.e. around 0.9% of GDP) than the EU average (0.58% of GDP. Notably Bulgaria and Estonia might experience the highest impact on the energy system costs and costs to mitigate non CO_2 emissions.

These results should be carefully interpreted. Proportional costs to GDP are not only higher because there may be a substantial GHG reduction and RES potential in Member States with a low GDP per capita and thus more associated costs. Another cause is it that their GDP levels remain far smaller than EU average. An equal absolute increase in the energy system costs translates therefore into a larger relative proportion compared to GDP.

Table 3: Costs per GDP (increased energy system costs and Non-CO2 mitigation costs) to achieve both the GHG and RES target cost efficiently for the whole EU

	Increased cost of total Energy system and cost of mitigation non CO2 as percentage of GDP in 2020*
EU	0,58%
AT	0,7%
BE	0,8%
BG	2,2%
CY	0,1%
CZ	1,1%
DK	0,3%
EE	1,6%
FI	0,5%
FR	0,4%
DE	0,6%
EL	1,0%
HU	1,2%
IE	0,5%
IT	0,5%
LV	1,1%
LT	1,0%
LU	0,5%
MT	0,3%
NL	0,3%
PL	1,2%
PT	0,9%
RO	0,9%
SK	1,2%
SI	0,9%
ES	0,7%
SE	0,7%
UK	0,5%

*** Source: Primes/Gains, this includes the costs to achieve cost efficient reductions in the EU-ETS and RES targets**

The impacts are compared to GDP at market prices and not GDP measured at Purchasing Power Parities. Eurostat calculates GDP at Purchasing Power Parities (PPPs) based on a survey of prices of commonly defined products, as such allowing to take into account different price levels in different Member States when measuring GDP. GDP at PPP reduces the relative differences between Member States' GDP per Capita within the EU. But these differences are to a large extent due to large differences in relative prices for consumer goods and much less so for capital goods, certainly for Machinery and equipment (see also Annex 3). A substantial share of the costs for implementing both the GHG and RES targets is generated through costs associated with capital good investments, the type of goods that see much less price differences within the EU. As such comparing the nominal costs of implementing the GHG and RES targets with GDP at PPP would underestimate the relative costs for those countries that have a relative large difference between their GDP at exchange rate and their GDP at PPP.

Table 4 represents the required reduction in the non ETS in the same cost efficient policy case as represented in **Table 3** for the whole EU for both achieving the 20% GHG and RES targets. In a cost efficient scenario emission reductions compared to 2005 differ substantially in the sectors not covered by the EU ETS. In Finland and the UK, the emissions in the baseline are already expected to decrease with more than 5% compared to 2005 and might thus decrease even more when additional mitigation policies are put in place with reductions of around 20% compared to 2005. On the other hand, Latvia sees a particularly large increase in baseline emissions, well over 50% compared to 2005 and therefore its emission reductions when additional mitigation policies are put in place are less pronounced, with an increase by 2020 of 24% compared to 2005 levels. Whereas 2020 emission reductions differ substantially between Member States compared to 2005 emission levels, emission reductions are more equally distributed compared to the 2020 PRIMES/GAINS baseline.

Table 4: Emissions reductions in the sectors not covered by the EU ETS in the cost efficient policy case compared to 2005

	Emission reductions in the non-ETS sectors 2020 compared to 2005	Emission reductions in the non-ETS sectors 2020 compared to PRIMES GAINS baseline in 2020
EU27	-12%	-14%
AT	-12%	-15%
BE	-14%	-17%
BG	-19%	-16%
CY	-7%	-13%
CZ	-7%	-12%
DK	-14%	-12%
EE	-3%	-15%
FI	-22%	-16%
FR	-15%	-15%
DE	-18%	-14%
EL	-10%	-16%
HU	-6%	-17%
IE	-17%	-15%
IT	-4%	-11%
LV	24%	-20%
LT	-2%	-18%
LU	-7%	-15%
MT	1%	-10%
NL	-14%	-14%
PL	-2%	-13%
PT	-10%	-12%
RO	-1%	-20%
SK	-1%	-14%
SI	7%	-14%
ES	-4%	-13%
SE	-7%	-14%
UK	-21%	-13%

Source: Primes/Gains

In order to assess the overall macroeconomic impacts on GDP and private consumption through the indirect effects between sectors, the GEM-E3 model was used. This model is not sufficiently detailed in its technology representation to determine targets between sectors and countries but it does allow assessing the impacts on the economic interactions between sectors which cannot be assessed by the PRIMES/GAINS model since that does not take into account the indirect economic impacts following the mitigation effort in the concerned sectors.

The model only considers CO2 emissions from energy. As such the reduction calculated is equal to around -16% CO2 by 2020 compared to 1990 (note that the Non-CO_2 gasses are reduced with more than 20% to ensure that the overall 20% commitment is achieved). Furthermore the GEM-E3 Europe model does not take into account the achievement of the 20% Renewables target. Overall projected cost estimates are below the expected total costs because they do not include the mitigation costs for the Non-CO2 emissions and the additional costs to achieve the 20% RES target.

When emissions would be reduced cost effectively for the EU as a whole, then GEM-E3 projects (see **Table 5**) a reduction in GDP equal to 0,54% compared to baseline, or in other words, total GDP in 2020 would be 0.54% lower than it would otherwise be without these policies. These cost impacts are limited, given that in baseline GDP is projected to increase with 38% over the period 2005-2020.

The carbon value is estimated at 50 € per ton CO_2 which is fully in line with the projections by the PRIMES/GAINS in the case that only the GHG commitment is achieved only and not the Renewables target (see chapter 5.2).

Private consumption is projected to go down in the EU but only too a very limited extent, i.e. with 0.11% and impacts on employment are estimated at a reduction of 0.41% by 2020.

The projections by GEM-E3 overall confirm the projections by PRIMES-GAINS that the impacts in terms of GDP in Member States with a lower than average GDP per capita are higher than the EU average. In this cost-efficient scenario, three new Member States would even have a decrease of GDP by 2020 compared to baseline that is higher than 2%.

Table 5: Macro economic impact of a cost efficient distribution and differentiated targets in the sectors not covered by the EU ETS

	Baseline	Cost efficient case		
Compared to baseline	GDP 2020 GDP 2005=100%	Net Change GDP 2020	Change Private Consumption 2020	Change Private Employment 2020
EU	138%	-0.54%	-0.11%	-0.41%
AT	137%	-0.4%	-0.1%	-0.3%
BE	139%	-0.5%	-0.1%	-0.3%
BG	155%	-2.5%	-1.1%	-0.5%
CZ	161%	-1.7%	-2.1%	-0.7%
DK	133%	-0.4%	-0.3%	-0.2%
EE	157%	-2.2%	-3.4%	-0.9%
FI	143%	-0.6%	-0.3%	-0.3%
FR	142%	-0.5%	0.0%	-0.3%
DE	129%	-0.5%	-0.1%	-0.3%
EL	145%	-0.9%	-0.6%	-0.6%
HU	157%	-1.7%	-1.4%	-0.8%
IE	154%	-0.3%	-0.4%	-0.5%

IT	138%	-0.4%	0.3%	-0.2%
LV	154%	-1.0%	-1.3%	-0.3%
LT	154%	-0.6%	0.1%	-0.5%
NL	141%	-0.6%	0.3%	-0.2%
PL	150%	-1.6%	-2.0%	-0.9%
PT	137%	-0.4%	0.1%	-0.3%
RO	149%	-2.6%	-1.9%	-0.8%
SK	167%	-1.7%	-0.2%	-0.8%
SI	137%	-0.7%	-0.6%	-0.5%
ES	149%	-0.7%	0.0%	-0.5%
SE	140%	-0.3%	0.0%	-0.2%
UK	136%	-0.4%	-0.2%	-0.3%

Source: GEM-E3 Europe

5.3.4.2. Equal Per capita emissions in the sectors not covered by the EU ETS

Average per capita EU emissions in the sectors not covered by the EU ETS, as defined in PRIMES/GAINS, are expected to be around 5.9 ton $CO_{2-eq.}$ in the baseline in 2020. The average drops to around 5,1 ton $CO_{2-eq.}$/capita in 2020 to meet the 20% GHG reduction and RES targets. On average the baseline foresees larger per capita emissions in the Member States with a GDP per capita above EU average and lower per capita emissions for those below.

8 Member States are projected to already have per capita emissions in the baseline case that are lower or equal than the EU average of 5,1 ton CO2-eq. per capita in the policy case and they are all Member States with a GDP per capita below EU average (Lithuania, Romania, Bulgaria Cyprus, Poland Slovakia, Malta and Portugal).

Countries that are below average already in the baseline would not have to introduce any additional reduction policies within the non-ETS sectors in the equal emissions/capita policy case and thus would have a carbon value for the non-ETS equal to 0 €/ton $CO_{2-eq.}$.

Instead, some of the EU15 Member States would require a high carbon value in the non-ETS sectors to reduce their emissions to the EU average. Luxemburg, Ireland and Belgium are projected not even to succeed with carbon values of the double and more of the EU average to limit their per capita emissions in the non-ETS to the required EU average[34].

5.3.4.3. Equal Percentage reduction compared to 2005

Another option is to reduce emissions to an equal extent compared to 2005 in all Member States. On average the reduction compared to 2005 in the sectors not covered by the ETS is projected to be around 12% in the EU (see also **Table 2**). 9 Member States from the EU15 are projected to reduce with 13% or more in the cost-efficient case. If emissions should reduce in the non-ETS sectors to an equal extent in all Member States, then these Member States would have to reduce less than in the cost efficient case. Notably Finland, UK, and Germany would have to reduce less.

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[34] This specific part of the analyis is based on the PRIMES baseline available end of July 2007 before consultation with MS 6 November. Otherwise the December 2007 baseline is used.

Instead most Members States with a below average GDP per capita would have to reduce emissions at a higher rate than the cost efficient case and as such experience higher carbon values. For several of these this would require carbon values of 80 € or more in the sectors not covered by the EU ETS.

5.3.4.4. Differentiation according to GDP/capita

In a cost-efficient approach at the EU level, member states with a low GDP per capita tend to have higher increased costs in the energy system proportional to GDP by 2020. Also on the Macroeconomic level losses in GDP tend to be higher. To take this into account the required efforts in the non-ETS sectors can be adjusted between Member States depending for instance on the relative level of GDP per capita.

Both in PRIMES/GAINS and GEM E3 a scenario was calculated to analyse the impact of differentiation the targets in the sectors not covered by the EU ETS, taking into account GDP per capita levels.

In the PRIMES/GAINS model a differentiation was made in two groups. A low income group including all Member States with a GDP that is % below the EU average. A high income group including all Member States with GDP per capita above EU average. It was assumed that the reduction effort would depend on the relative position of GDP/Capita of the Member States. Member States with a high GDP per capita would need to reduce more, Member States with a low GDP per capita would need to reduce less.

Member States in the low income group would need to reduce less than the EU average of -12% below 2005 levels and 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 in the high income group would need to reduce more than the EU average of -12% below 2005 levels, with a maximum reduction of -20% below 2005 levels. This would result in the following reduction profile of % reduction in the non EU ETS as a function of GDP/cap across EU Member States:

Figure 2: Reduction profile in the sectors not covered by the EU ETS after modulation taking into account relative GDP per capita

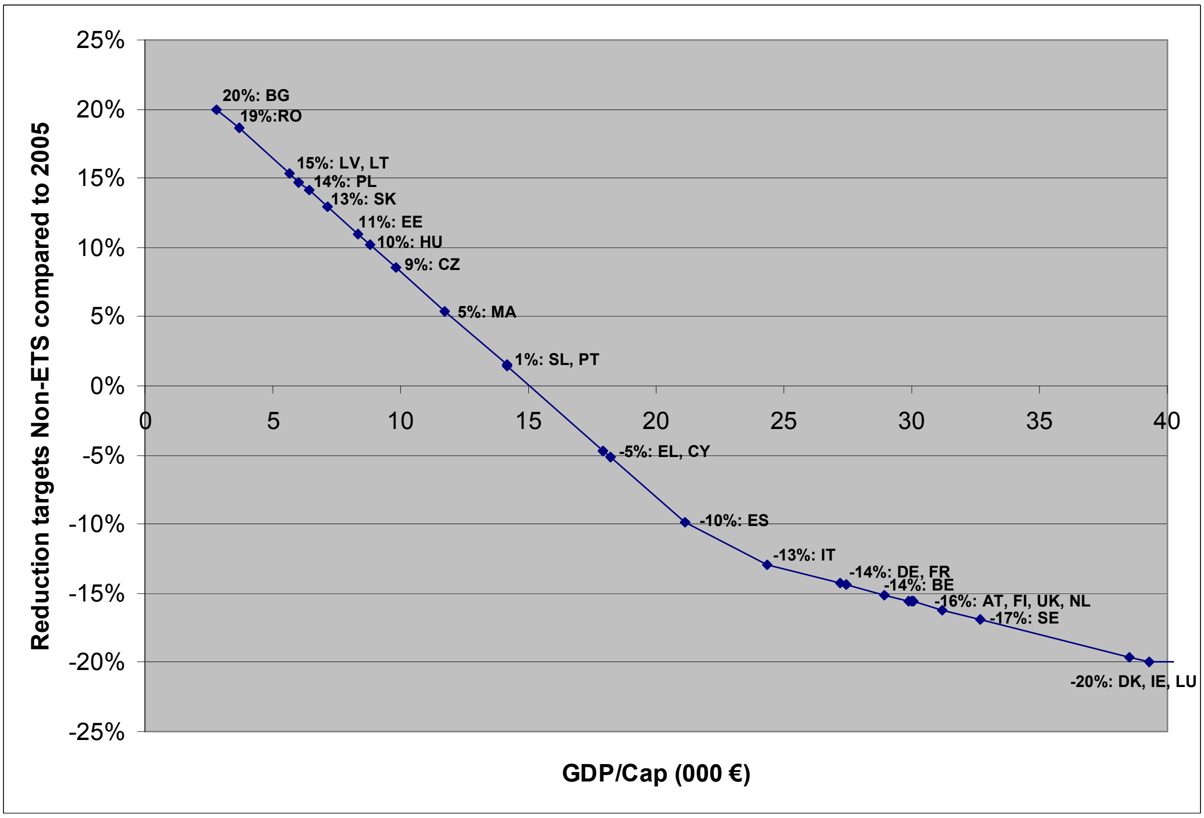

Table 6 represents the results of such a scenario and compares them with the cost efficient case. For the low income group this resulted in substantially lower reduction targets in the non-ETS sectors, with most of them seeing a net increase of GHG emissions in those sectors compared to 2005. Note that these results include a cost effective achievement of the RES target. Thereby emissions in the sectors not covered by the EU ETS may be below the baseline projections even if the required carbon value to achieve the targets in the Non-ETS is equal to 0 € since the penetration of renewables in the transport, residential and domestic sector might be higher to meet the renewable target.

The differentiation reduces the energy system and non-CO2 mitigation costs (as % of GDP) for Member States with a GDP per capita below EU average. The costs are projected to be equal to the cost efficient case for Cyprus and might even increases for Slovenia and Latvia even with an allowed increase in emissions in the non-ETS sector of +2% and +16% compared to 2005. For other Member States with a low GDP per capita, costs could decrease to below 1 % of GDP, with the exception of Bulgaria and Estonia.

For the high income group the required changes in GHG reductions compared to the cost efficient scenario could be more mixed. For 9 Member States the reductions are more ambitious than in the cost efficient case. For 4 high income countries the effort is lower than the one required in the cost efficient case.

The cost increase per GDP at the EU level is projected to be limited, increasing with 0.03% even though substantial differences exist most notably in Italy and Spain where the cost per

GDP might increase with 0.5%. Carbon prices vary substantially in the sectors not covered by the EU ETS.

This distribution of targets does lower the overall effort in the PRIMES/GAINS projections for the sectors not covered by the EU ETS. Their reduction effort decreases from -12% to -10% compared to 2005 causing the EU ETS effort (excluding aviation) to increase from -21% to -23%. The costs as represented in **Table 6** also include the costs due to the increased effort in the EU ETS.

Table 6: Emissions reductions in the non-ETS in the cost efficient policy case for the EU with a modulation of the effort in the non-ETS sectors according to GDP

	Increased cost of Energy system + cost mitigation Non CO2 proportional to GDP in 2020		Change 2020 GHG emissions non-ETS sectors compared to 2005		Carbon value Non ETS sectors in 2020	
	Non –ETS target modulated according to GDP/CAP	Cost efficient case	Non –ETS target modulated according to GDP/CAP	Cost efficient case	Non –ETS target modulated according to GDP/CAP	Cost efficient case
EU	0.61%	0.58%	-10%	-12%	37	39
AT	0.9%	0.7%	-16%	-12%	62	39
BE	0.8%	0.8%	-15%	-14%	42	39
BG	1.1%	2.2%	20%	-19%	0	39
CY	0.1%	0.1%	-5%	-7%	31	39
CZ	0.5%	1.1%	9%	-7%	0	39
DK	0.6%	0.3%	-20%	-14%	81	39
EE	1.1%	1.6%	11%	-3%	4	39
FI	0.5%	0.5%	-16%	-22%	20	39
FR	0.4%	0.4%	-14%	-15%	37	39
DE	0.5%	0.6%	-14%	-18%	25	39
EL	0.8%	1.0%	-5%	-10%	27	39
HU	0.5%	1.2%	10%	-6%	5	39
IE	0.6%	0.5%	-20%	-17%	57	39
IT	1.0%	0.5%	-13%	-4%	92	39
LV	1.7%	1.1%	15%	24%	71	39
LT	0.5%	1.0%	15%	-2%	3	39
LU	0.9%	0.5%	-20%	-7%	88	39
MT	0.2%	0.3%	5%	1%	22	39
NL	0.3%	0.3%	-16%	-14%	47	39
PL	0.5%	1.2%	14%	-2%	0	39
PT	0.5%	0.9%	1%	-10%	0	39
RO	0.4%	0.9%	19%	-1%	4	39
SK	0.8%	1.2%	13%	-1%	2	39
SI	1.4%	0.9%	1%	7%	63	39
ES	1.2%	0.7%	-10%	-4%	72	39
SE	0.7%	0.7%	-17%	-7%	87	39
UK	0.4%	0.5%	-16%	-21%	19	39

Source: PRIMES/GAINS

Similarly in GEM-E3 the emission reduction levels where differentiated between Member States for the emissions in sectors not covered by the EU ETS. Low income group received reduction efforts lower than the EU average while high income group received reduction efforts higher than the EU average, again capped at the high and low end.

The overall impact in GDP increases because the allocation is cost inefficient but remains limited at a further decrease of GDP with 0,14%. The net improvement of the cost impact on GDP by 2020 for Member States with a GDP per capita below EU average is substantial with reductions on the GDP impact gradually going up to 1.3% of GDP for Bulgaria. The only exception is Slovenia where the impact on GDP is negative. This is because the distributed target according to GDP per capita would require them to do -3% more reductions in the sectors not covered by the EU ETS than in the cost efficient case. In 4 Member States of the EU15 the impact on GDP is projected to be positive or neutral (Italy, Spain, Portugal and Greece), 3 of them are Member States with a GDP per capita below EU average. In the other Member States impacts on GDP are negative and many of them are projected to have a GDP decline above the EU average.

Private consumption decreases with a further 0,19% compared to the cost effective allocation for the EU as a whole but increases substantially for the Member States with a GDP per capita below EU average, again with the exception of Slovenia. The impact on employment is almost nil at the EU level (a reduction of -0.02%) as a whole but employment improves overall substantially in the Member States with a GDP per capita below EU average compared to the cost efficient case. The more ‘equitable’ distribution of the reduction effort in the sectors not covered by the EU ETS reduce thus the burden considerably on the Member States with a GDP per capita below EU average. This limits the increase in the prices of their goods in those sectors not covered by the ETS. It induces thus less impacts in the Member States with a GDP per capita below EU average compared to the other EU countries where the costs in the sectors not covered by the EU ETS are higher and the impacts on GDP are negative.

Table 7: Macro economic impact of a cost efficient distribution and differentiated targets in the sectors not covered by the EU ETS

	Baseline	Cost efficient case			Differentiating targets in sectors not covered by the EU ETS with lower targets for Member States with a GDP per capita below EU average compared to the cost efficient case			
	GDP 2020	Change GDP 2020	Change Private Consumption 2020	Change employment 2020	Differentiated target compared to cost efficient case	Change GDP by 2020	Change Private Consumption 2020	Change employment 2020
EU	138%	-0.54%	-0.11%	-0.41%	0%	-0.68%	-0.23%	-0.43%
AT	137%	-0.4%	-0.1%	-0.3%	-5%	-0.5%	-0.2%	-0.4%
BE	139%	-0.5%	-0.1%	-0.3%	-9%	-0.9%	-0.5%	-0.5%
BG	155%	-2.5%	-1.1%	-0.5%	23%	-1.3%	-0.2%	-0.2%
CZ	161%	-1.7%	-2.1%	-0.7%	31%	-1.2%	-1.4%	-0.4%
DK	133%	-0.4%	-0.3%	-0.2%	-13%	-0.9%	-0.8%	-0.4%
EE	157%	-2.2%	-3.4%	-0.9%	12%	-1.6%	-2.7%	-0.7%
FI	143%	-0.6%	-0.3%	-0.3%	-9%	-0.8%	-0.7%	-0.4%
FR	142%	-0.5%	0.0%	-0.3%	-11%	-1.1%	-0.7%	-0.7%

DE	129%	-0.5%	-0.1%	-0.3%	-2%	-0.5%	-0.1%	-0.4%
EL	145%	-0.9%	-0.6%	-0.6%	7%	-0.7%	-0.2%	-0.5%
HU	157%	-1.7%	-1.4%	-0.8%	26%	-0.8%	-0.3%	-0.4%
IE	154%	-0.3%	-0.4%	-0.5%	-14%	-0.8%	-1.6%	-1.1%
IT	138%	-0.4%	0.3%	-0.2%	1%	-0.4%	0.4%	-0.2%
LV	154%	-1.0%	-1.3%	-0.3%	21%	-0.3%	-0.3%	-0.1%
LT	154%	-0.6%	0.1%	-0.5%	16%	-0.3%	0.7%	-0.2%
NL	141%	-0.6%	0.3%	-0.2%	-3%	-0.7%	0.3%	-0.3%
PL	150%	-1.6%	-2.0%	-0.9%	28%	-1.0%	-1.1%	-0.6%
PT	137%	-0.4%	0.1%	-0.3%	1%	-0.4%	0.2%	-0.3%
RO	149%	-2.6%	-1.9%	-0.8%	32%	-1.7%	-0.9%	-0.5%
SK	167%	-1.7%	-0.2%	-0.8%	18%	-0.8%	0.8%	-0.4%
SI	137%	-0.7%	-0.6%	-0.5%	-3%	-0.8%	-0.8%	-0.7%
ES	149%	-0.7%	0.0%	-0.5%	-1%	-0.7%	0.0%	-0.5%
SE	140%	-0.3%	0.0%	-0.2%	-14%	-0.7%	-0.5%	-0.5%
UK	136%	-0.4%	-0.2%	-0.3%	-3%	-0.5%	-0.2%	-0.3%

Source: GEM-E3 Europe

Conclusion

1. A cost effective reduction in the sectors not covered by the EU ETS results in a proportionally higher increase (at least 50% higher than the EU average) in the overall cost of the energy system compared to GDP for the Member States with a GDP per capita below EU average than for other countries. Also the reduction in net GDP by 2020 tends to be higher in Member States with a GDP per capita below EU average.

2. If reduction efforts in the sectors not covered by the EU ETS are required to reduce emissions to a level that would see *per capita* emissions in those sectors converge within the EU, then some EU-15 Member States are not expected to achieve these efforts.

3. An equal percentage reduction per Member State compared to 2005 would require GHG emissions in the sectors not covered by the EU ETS to reduce with around 12 % in each Member State. This would require much larger efforts for most Member States with a GDP per capita below EU average compared to the cost efficient case.

4. Decreasing the targets in the Non-ETS for countries with lower GDP per capita and increasing them for countries with higher GDP per capita increases overall costs in the EU. But while these cost increases remain limited across the whole EU, cost reductions can be very substantial in those countries with a very low GDP per capita relative to the EU average. Overall, the cost increases for the energy system range in a much narrower band around the EU average, giving a more equal effort across the EU Member States. If applied, most countries with a low GDP per capita could be allowed to emit more than they did in 2005 in those sectors not covered by the EU ETS.

5.3.5. GHG reduction commitment, relationship with auctioning under the EU ETS

The impact assessment for the proposal to amend Directive 2003/87/EC[35] has assessed the introduction of more auctioning in the EU ETS. Allocations for free have had significant redistribution effects, most prominently but not exclusively in the power generating sector[36]. In competitive markets, charging the opportunity cost of resources, whether received for free or not, is rational economic behaviour for any market participant[37]. Moreover, allocating allowances for free has reduced the efficiency of the ETS, weakening the signal that stems from the CO2-price in particular with respect to decisions to close old installations with relatively high emissions and with respect to decisions to invest in low-emitting technology. Furthermore the variety in allocation methodologies has generated distortions of competition across Member States.

Differences in allocation levels have been most pronounced in the power generating sector, but were equally present in industrial sectors, i.a. due to the burden sharing agreement which included the EU ETS sectors, application of different reduction factors, due to different methods to account for expected production growth and due to different ways to take into account early action and clean technology[38]. Location decisions of investors may be distorted particularly by rules for allocating to new installations and by transfer rules which restrict the benefit of keeping allowances after closure to the same operator, site or to investment in the same Member State.

The conclusion reached in the impact assessment for the proposal to amend Directive 2003/87/EC is that the preferred long term option is full auctioning with free allocation taking place in accordance with EU-wide rules for a transitional period, and taking into account progress in reaching an international agreement for those installations in certain sectors to avoid net carbon leakage.

Macro Economic Impacts of auctioning

The GEM-E3 model was used to assess the macro-economic implications of introducing a carbon value in the different sectors that generates revenues for the authorities that can then be recycled into the economy. Policies that could reduce greenhouse gas emissions efficiently and can generate revenues that can be recycled are for instance auctioning and taxation.

Increased auctioning in the ETS sectors or the introduction of taxation schemes in the sectors not covered by the EU ETS could generate substantial revenues. Three scenarios were

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[35] Accompanying document to the Proposal for a Directive of the European Parlemanet and of the Council amending Directive 2003/87/EC so as to improve and extend the EU greenhouse gas emission allowance trading system, Impact Assessment.

[36] See e.g. Cramton 2002, Sijm 2006a, Sijm 2006b, Smale 2006, Walker 2006. When addressing the distributional effects of the ETS, solutions must be sought in the allocation methods. Inclusion of the price of allowances in final product prices is an intended effect of the ETS, as it ensures correct carbon price signals, shifting demand towards less emission-intensive products. Such substitution effects are essential for achieving emission reductions at lowest cost.

[37] As the EU ETS should affect all players in a sector in the same way, under perfect competition and perfect grandfathering, full inclusion of the opportunity cost in prices is the expected market result.

[38] Apart from effects on actual production and pricing, allocations also affect financing costs and financial power of the companies concerned.

calculated with the GEM-E3 model to assess the potential impact of the introduction of a carbon value together with revenue recycling:

> - A scenario that introduces a carbon value to achieve cost efficient reductions across all sectors and Member States but without the generation of revenues or thus the recycling of these revenues in the economy. Such a scenario reflects perfect free allocation in the EU ETS and cost efficient optimal command and control regulation in the sectors not covered by the EU ETS.
>
> - A scenario that introduces a carbon value to achieve cost efficient reductions across all sectors and Member States, with generation of revenues in the EU-ETS but no such revenue generation in the sectors not covered by the EU ETS. Such a scenario reflects full auctioning in the EU ETS and cost efficient optimal command and control regulation in the sectors not covered by the EU ETS. The revenues generated through the auctioning are recycled back into the economy through transfers back to households.
>
> - A scenario that introduces of a carbon value to achieve cost efficient reductions across all sectors and Member States, with generation of revenues in all sectors. Such a scenario reflects full auctioning in the EU ETS and taxation schemes in the sectors not covered by the EU ETS. The revenues generated through the auctioning and taxation schemes are recycled back into the economy through transfers back to households.

The GEM-E3 model assumes that companies maximise profits, and as such incorporate opportunity costs to the effect that they can do so given the competitive pressures experienced from competitors within and outside the EU.

Overall, revenue generation and the recycling through a transfer to households reduces the negative impacts on GDP (see Table 8) while the carbon value remains around 50 €. With only free allocation the negative GDP effect by 2020 is projected to be just above half a percent. With the introduction of auctioning in the EU ETS this reduces to -0.35%. Most member states' GDP improves with the exception of Estonia, Slovakia and Lithuania where the impact of auctioning seems to be larger than the recycling effects of increased consumer spending in the economy. The redistribution through transfers to households favours private consumption without direct compensation for the firms. This is reflected in the differentiated impact on GDP and private consumption whereby the impact on the latter is much more outspoken positive, changing from a net loss in private consumption to a net gain. Total employment increases in the case of auctioning compares to a situation of free allocation, and total employment effects of meeting targets is estimated to be extremely small in the case of auctioning in the EU ETS. Greater employment in other sectors, stimulated by increased consumer demand, seems more than any loss due to auctioning in the ETS sectors and taxation in the sectors not covered by the EU ETS.

The impact of the introduction of revenue generation through for instance taxation in the sectors not covered by the EU ETS is much less outspoken in the projections. Compared to the situation that revenue is only generated through auctioning in the EU ETS the additional impacts at the EU level are minimal. The impact on GDP still remains at -0.35% while private consumption and employment change only marginally. Nevertheless there are positive effects in several Member States with a GDP per capita below EU average both for GDP and private consumption but a negative effect on employment, indicating that supply of labour decreases due to increased welfare through increased consumer consumption.

The modelling described above assumes revenues to be returned to consumers, whereas another possibility is to use the revenues for reducing labour cost. In the latter case the positive impacts on employment may be more significant. This has been illustrated by modelling carried out in support of the Impact Assessment in the context of the Review of Directive 2003/87/EC (Task 2, Further harmonisation and increased predictability, 2007, chapter 8). This modelling also confirms the possible positive effects from auctioning on GDP compared to free allocation.

Table 8 Macro economic impacts of auctioning given a cost effective achievement of the 20% GHG reduction commitment

	Cost efficient case, no revenue generation in the EU ETS and Non-ETS			Cost efficient case, auctioning in the EU ETS and no revenue generation Non-ETS			Cost efficient case, auctioning in the EU ETS and revenue generation Non-ETS through for instance taxation		
	Change GDP	Change Private Consump -tion	Change employ-ment	Change GDP	Change Private Consump-tion	Change employ-ment	Change GDP	Change Private Consump-tion	Change employ-ment
EU	-0.54%	-0.11%	-0.41%	-0.35%	0.19%	-0.04%	-0.35%	0.23%	-0.06%
AT	-0.4%	-0.1%	-0.3%	0.0%	0.3%	0.4%	0.0%	0.3%	0.4%
BE	-0.5%	-0.1%	-0.3%	-0.4%	0.2%	0.0%	-0.4%	0.5%	-0.1%
BG	-2.5%	-1.1%	-0.5%	-2.4%	1.3%	-0.5%	-2.2%	3.8%	-0.6%
CZ	-1.7%	-2.1%	-0.7%	-1.7%	0.2%	-0.7%	-1.7%	1.0%	-0.9%
DK	-0.4%	-0.3%	-0.2%	-0.1%	-0.1%	0.4%	-0.1%	0.2%	0.3%
EE	-2.2%	-3.4%	-0.9%	-2.3%	-0.4%	-1.1%	-2.5%	1.4%	-1.4%
FI	-0.6%	-0.3%	-0.3%	-0.6%	0.4%	-0.3%	-0.6%	0.6%	-0.3%
FR	-0.5%	0.0%	-0.3%	-0.3%	0.1%	0.0%	-0.3%	0.1%	0.0%
DE	-0.5%	-0.1%	-0.3%	-0.3%	0.1%	-0.1%	-0.3%	0.1%	-0.1%
EL	-0.9%	-0.6%	-0.6%	-0.8%	-0.2%	-0.3%	-0.8%	-0.1%	-0.3%
HU	-1.7%	-1.4%	-0.8%	-1.5%	-0.8%	-0.4%	-1.5%	-0.6%	-0.4%
IE	-0.3%	-0.4%	-0.5%	0.2%	-0.1%	1.3%	0.2%	-0.2%	1.3%
IT	-0.4%	0.3%	-0.2%	-0.1%	0.5%	0.3%	-0.1%	0.5%	0.3%
LV	-1.0%	-1.3%	-0.3%	-0.9%	-0.8%	-0.2%	-1.0%	0.0%	-0.3%
LT	-0.6%	0.1%	-0.5%	-0.6%	0.9%	-0.5%	-0.6%	0.9%	-0.5%
NL	-0.6%	0.3%	-0.2%	-0.4%	0.5%	0.1%	-0.4%	0.7%	0.1%
PL	-1.6%	-2.0%	-0.9%	-1.5%	-0.8%	-0.7%	-1.5%	-0.1%	-0.7%
PT	-0.4%	0.1%	-0.3%	-0.3%	0.4%	-0.1%	-0.3%	0.2%	-0.1%
RO	-2.6%	-1.9%	-0.8%	-2.4%	1.6%	-0.8%	-2.4%	3.0%	-0.9%
SK	-1.7%	-0.2%	-0.8%	-1.7%	1.3%	-0.8%	-1.9%	3.9%	-1.1%
SI	-0.7%	-0.6%	-0.5%	-0.6%	-0.4%	-0.5%	-0.6%	-0.8%	-0.4%
ES	-0.7%	0.0%	-0.5%	-0.1%	0.7%	0.8%	-0.1%	1.0%	0.8%
SE	-0.3%	0.0%	-0.2%	-0.2%	0.1%	-0.1%	-0.3%	0.2%	-0.2%
UK	-0.4%	-0.2%	-0.3%	-0.3%	-0.1%	-0.1%	-0.3%	-0.2%	-0.1%

Source: GEM-E3 Europe

Table 8 clearly demonstrates the significant macro-economic benefits of increased levels of auctioning compared to a situation of only grandfathering. This result supports the case for increased use of auctioning in the proposal to amend the EU ETS, on top of the other reasons listed above that support this increased use.

In the sectors not covered by the EU ETS Members States hold key competences to define policies and measures, including the right to implement further taxation. If emissions are not reduced through taxation then other policies such as efficient standards and road traffic management will need to be put in place. The costs as presented in **Table 8** could increase if Member States would not implement such a mix of policies cost effectively.

Financial Valuation of auctioning

In **Table 9** the potential revenues of auctioning allowances for each Member State is presented on the basis of projections by the PRIMES model for two cases: i.e. full auctioning is applied by 2020 to all ETS sectors including aviation or only within Power sector. **Table 9** is based on a scenario that achieves both the GHG and RES targets cost efficiently (see also **Table 3** for the associated costs proportional to GDP) without access to JI/CDM. The amount of allowances that the ETS sectors need to acquire is in many Member States with a GDP per capita below EU average proportionally higher compared to GDP than the EU average. This could be due to relative higher share of emissions from the ETS sector in several Member States with a GDP per capita below EU average and due to the fact that their GDP is often comparably substantially lower than the EU average.

This can be seen also in Table 8 where the gains in private consumption are much larger for the Member States with a GDP per capita below EU average than for the richer Member States while the GDP effects are less outspoken in the Member States with a GDP per capita below EU average than in the richer Member States. This is most probably due to the relative larger share in their economy of ETS sectors compared to the richer member states, thereby having relative larger impacts on private consumption through the recycling of auctioning revenues.

Table 9: Potential auctioning revenues generated in Member States in 2020[39]

	Auctioning revenues in Billion € with carbon price = 39,2 €/ton $CO_{2\text{-eq.}}$		Potential auctioning revenues as % of GDP	
	Power + Aviation	All ETS sectors*	Power + Aviation	All ETS
EU	38.8	75.5	0.2%	0.5%
AT	0.3	1.0	0.1%	0.3%
BE	1.0	2.3	0.2%	0.6%
BG	0.5	1.1	1.1%	2.2%
CY	0.1	0.1	0.3%	0.6%
CZ	1.3	2.2	0.8%	1.2%
DK	0.4	0.7	0.2%	0.3%
EE	0.2	0.3	0.9%	1.4%
FI	0.5	0.9	0.2%	0.4%

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[39] In this table it is assumed that each Member State receives the revenues of the acquisitions by its own ETS-sector in 2020.

FR	0.5	4.2	0.0%	0.2%
DE	11.3	17.8	0.4%	0.6%
EL	0.9	1.7	0.3%	0.6%
HU	0.3	0.8	0.2%	0.5%
IE	0.3	0.8	0.1%	0.3%
IT	5.1	8.8	0.3%	0.5%
LV	0.0	0.1	0.1%	0.4%
LT	0.1	0.2	0.2%	0.4%
LU	0.0	0.1	0.1%	0.3%
MT	0.0	0.0	0.3%	0.5%
NL	1.7	3.4	0.2%	0.5%
PL	4.3	6.8	0.9%	1.4%
PT	0.5	1.1	0.2%	0.5%
RO	1.0	2.8	0.5%	1.5%
SK	0.3	1.0	0.4%	1.3%
SI	0.1	0.2	0.3%	0.5%
ES	3.0	6.4	0.2%	0.5%
SE	0.0	0.9	0.0%	0.2%
UK	4.9	9.5	0.2%	0.4%

Source: PRIMES/GAINS

Does auctioning have an Impact on the reduction levels in the EU ETS?

The results in **Table 8** with the GEM E-3 model represent a cost efficient reduction across all Member States and sectors, with and without full auctioning. The projected emission reductions for the EU ETS are almost identical with or without auctioning in the ETS at EU level (a difference of less than 0.25%), indicating that introducing auctioning does not have a significant effect on the cost efficient reduction rate in the sectors covered by the EU ETS.

A similar analysis was carried out with the PRIMES model. Three extreme scenarios where calculated: one with no auctioning at all, one with auctioning in the power & district heating sectors (including all CHP) and one with auctioning extended to all energy related emissions in the ETS sectors. The emissions did reduce with around 1% more in the scenario with auctioning only in the power sector compared to the scenario with no auctioning at all. The reduction of emissions in the scenario with auctioning in all sectors was much closer to the scenario with partial auctioning to only the power sector.

This seems to indicate that auctioning in the power sector might indeed lead to more energy efficient use of electricity through price increases (to the extent that they would not have been incorporated yet through inclusion of the opportunity cost). But it should be noted that the scenarios with auctioning actually led to an overshoot of the GHG commitment while carbon price and the RES incentive where kept constant. In order not to overshoot the overall GHG reduction commitment, carbon values could actually be lower in the EU ETS with auctioning, thus lowering also the optimal reduction rate in the EU ETS bringing them closer to the reduction rates as would be the case if allocation is free.

Distribution of auctioning rights between Member States

Auctioning rights can be shared between Member States according to different options. In the model results presented above in **Table 8** and **Table 9** it was assumed that each Member State receives the revenues of the acquisitions by its own ETS-sector in 2020. As such, from a country perspective the amount paid for allowances by its companies are equal to the revenue generated for that Member State. Practically such distribution of auctioning rights would also imply that revenues are only attributed to Member States after the emission levels are know in the Member States for the ETS sectors that have no free allocation. Implementing such an auctioning distribution would require a central organisation that (re)distributes the auctioning revenues only after the emissions are reported of the ETS sectors, or alternatively update auctioning rights in accordance with the emissions in preceding years. This would not allow Member States to anticipate with certainty the amount of auctioning revenues that they might receive.

A second issue relates to the fact that, even taken into account targets in non EU ETS sectors that are GDP/cap modulated, the overall increased energy costs are still relatively high in a number of countries with a low GDP/cap. These relatively higher costs could be due to larger, cost-effective renewable potentials as well as large efforts in the EU ETS sectors. 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 balance the efforts of Member States..

Other options have been considered that would determine the amount a Member State is allowed to auction. This would require a distribution key defined ex ante to share out the total cap of allowances that will be auctioned. The following options are further elaborated:

> - Option 1: Proportional to the real emissions in the EU ETS by 2020: If there is no access to JI/CDM then this would be the same auctioning distribution as presented in **Table 8** and **Table 9**.
>
> - Option 2: Proportional to the commitments under the Kyoto Protocol: Each Member State may auction proportional to the total allowed emissions per Member State under the first commitment period of the Kyoto Protocol. For Cyprus and Malta, who do not have a commitment under the Kyoto Protocol, a -8% GHG reduction commitment was assumed compared to 1990 emission levels.
>
> - Option 3: Proportional to 2005 EU ETS emissions: Each Member State may auction proportional to the emissions of its EU ETS sectors in 2005 ETS.
>
> - Option 4: Proportional to 2005 EU ETS but modulated according to GDP:
>
> Step 1: The basic distribution rule is the same as option 3, i.e. an allocation proportional to the emissions of the 2005 ETS sector.
>
> Step 2: 90% of the total cap is auctioned according to step 1.
>
> Step 3: The remaining 10% is only allocated to, and can thus be auctioned only by those Member States that have a GDP that is lower than 120% of the EU average. The amount that each of these individual Member States auction is determined by increasing the amount that they receive under step 2 by the % listed in column (1) of **Table 10**. These percentages are determined according to the following rule: the lower GDP per capita and the higher expected overall GDP growth, the more auctioning rights the Member State receive.

This results in an auctioning distribution that gives Member States with a high GDP per capita an allocation equal to 90% of the auctioning cap resulting from option 3 (auctioning cap distributed proportional to 2005 emission levels in the EU ETS). Member States with a lower GDP per Capita would receive more auctioning rights than under option 3. Column (2) of **Table 10** gives the share that Member States would receive under option 4 compared to option 3.

Table 10: Auctioning rights redistribution key on the basis of GDP

<table>
<tr><td colspan="3">Basic allocation rule:
90% of the auctioning cap is distributed according to proportional 2005 emissions in the EU ETS</td></tr>
<tr><td colspan="3">10% redistribution:
10% of the auctioning cap is redistributed, increasing the amount that can be auctioned by a member state under the basic allocation rule with the % listed in column (1)</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">(1)</td><td>(2)</td></tr>
<tr><td>% auctioning rights received by a Member State after redistribution compared to an allocation that would distribute all auctioning rights according to proportional 2005 emissions in the EU ETS</td></tr>
<tr><td>AT</td><td>0%</td><td>90%</td></tr>
<tr><td>BE</td><td>0%</td><td>90%</td></tr>
<tr><td>BG</td><td>53%</td><td>138%</td></tr>
<tr><td>CY</td><td>20%</td><td>108%</td></tr>
<tr><td>CZ</td><td>31%</td><td>118%</td></tr>
<tr><td>DK</td><td>0%</td><td>90%</td></tr>
<tr><td>EE</td><td>42%</td><td>128%</td></tr>
<tr><td>FI</td><td>0%</td><td>90%</td></tr>
<tr><td>FR</td><td>0%</td><td>90%</td></tr>
<tr><td>DE</td><td>0%</td><td>90%</td></tr>
<tr><td>EL</td><td>17%</td><td>105%</td></tr>
<tr><td>HU</td><td>28%</td><td>115%</td></tr>
<tr><td>IE</td><td>0%</td><td>90%</td></tr>
<tr><td>IT</td><td>2%</td><td>92%</td></tr>
<tr><td>LV</td><td>56%</td><td>140%</td></tr>
<tr><td>LT</td><td>46%</td><td>131%</td></tr>
<tr><td>LU</td><td>0%</td><td>90%</td></tr>
<tr><td>MT</td><td>23%</td><td>111%</td></tr>
<tr><td>NL</td><td>0%</td><td>90%</td></tr>
<tr><td>PL</td><td>39%</td><td>125%</td></tr>
<tr><td>PT</td><td>16%</td><td>104%</td></tr>
<tr><td>RO</td><td>53%</td><td>138%</td></tr>
<tr><td>SK</td><td>41%</td><td>127%</td></tr>
<tr><td>SI</td><td>20%</td><td>108%</td></tr>
<tr><td>ES</td><td>13%</td><td>102%</td></tr>
<tr><td>SE</td><td>0%</td><td>90%</td></tr>
<tr><td>UK</td><td>0%</td><td>90%</td></tr>
</table>

The table underneath represents the resulting allocation of auctioning rights for these different options for the projections by the PRIMES/GAINS model in the case that all sectors in the EU ETS experience auctioning, that both the RES and GHG targets are met cost-efficiently and that there is no access to JI/CDM. In this case the emissions in the EU ETS, excluding aviation, are expected to have to decrease with -21% compared to 2005 to approximately 1720 million ton CO_2 .

If auctioning rights were allocated proportional to the Kyoto Commitments (column 2) than all Member States with a GDP per capita below EU average would receive a share of auctioning which is higher than the quantity of allowances that their ETS sectors are projected to acquire in a cost efficient scenario (column 1 of **Table 11**) with the exception of Portugal, Spain, Slovakia and Cyprus. For the richer Member States the results are mixed with some receiving more and some less than their ETS sectors need to acquire.

If auctioning rights were allocated proportional to the 2005 emission levels in the EU ETS (column 3 **Table 11**) than the number of additional Member States with a GDP per capita below EU average that would receive less auctioning rights than their sectors need to acquire increases with four (Poland, Latvia, Slovakia and Romania).

If auctioning rights were to be allocated proportionally to the 2005 emission levels in the EU ETS but with 10% modulated according to GDP (column 4) then all Member States with a GDP per capita below EU average would receive more auctioning rights than their sectors need to acquire. Several would receive even more than if the commitments under the Kyoto Protocol would be used as an allocation key. For the richer Member States the results remain mixed.

Table 11: Options of relative shares per Member State of the total EU ETS auctioning cap for different auctioning rights distributions (in MtCO2)

	Amount Member State can auction out of the total EU ETS auctioning cap in 2020			
	Option 1	Option 2	Option 3	Option 4
	Proportional to the real emissions in the EU ETS by 2020	Proportional to the commitments under the Kyoto Protocol	Proportional to 2005 EU ETS emissions	Proportional to 2005 EU ETS but modulated according to GDP
	(1)	(2)	(3)	(4)
EU	1720	1720	1720	1720
AT	23.0	22.0	26.5	23.8
BE	52.8	43.6	43.3	39.0
BG	27.0	39.0	30.5	42.1
CY	2.2	1.9	2.9	3.1
CZ	53.9	57.9	64.7	76.3
DK	15.2	17.5	20.8	18.7
EE	8.1	12.7	9.9	12.7
FI	21.7	22.8	26.3	23.6
FR	83.2	180.8	107.0	96.3
DE	417.9	312.1	380.4	342.4
EL	38.1	44.5	51.2	53.6
HU	18.7	37.1	21.5	24.8
IE	17.2	20.2	17.6	15.8
IT	207.9	155.7	176.9	163.1
LV	2.7	7.6	2.3	3.2
LT	4.5	14.2	5.2	6.9
LU	2.4	2.9	2.0	1.8
MT	0.6	0.7	1.5	1.6

NL	73.8	64.7	66.2	59.5
PL	171.4	176.8	164.3	205.3
PT	24.9	24.8	29.2	30.5
RO	71.0	83.3	55.5	76.8
SK	25.6	21.6	21.1	26.8
SI	5.8	6.0	6.8	7.4
ES	139.3	106.7	148.7	151.3
SE	18.4	24.1	16.7	15.0
UK	192.6	218.8	221.1	199.0

Source: PRIMES/GAINS

Table 12 tries to give an indication of how such an auctioning redistribution relates to the expected increase in energy system and non Non CO2 costs. (as estimated in **Table 3**). These energy and non-CO2 costs in each country are 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 by 2020.

Distributing auctioning rights according to the projected real emissions in the EU ETS by 2020 or redistributing them through a distribution key that takes into account the relative GDP of Member States have different impact on overall costs, certainly in the Member States with the very low GDP per capita where relative small shifts in the right to auction, are relative large compared to GDP. A GDP modulated distribution is expected to reduce the impact significantly in new Member States, from a net cost (costs minus net auction revenues) of 1.15% of GDP to 0.87% without a substantial increase for the EU15, with an increase from 0.53% to 0.55%. With the exception of Malta and Cyprus, average costs in all options remain higher for Member States with a GDP per capita below EU average than the EU average of 0.58%.

Table 12: Impact on overall cost of different options to share the revenue of auctioning

Impact on overall costs per GDP on the basis of distributing auctioning revenues

(auctioning assumed in the whole EU ETS)

Cost is defined as =
Increased cost to the energy system and mitigation costs non CO2
+ cost auctioning rights bought by companies in the ETS
– revenue received by Member State from Auctioning

Compa-red to baseline	Cost efficient case and auctioning per Member State equal to real emissions in the EU ETS by 2020	Cost efficient case and auctioning rights determined proportional to 2005 EU ETS but modulated according to GDP
EU	0.58%	0.58%
NMS	1.15%	0.87%
EU15	0.53%	0.55%
AT	0.7%	0.7%
BE	0.8%	0.9%
BG	2.2%	1.0%

CY	0.1%	-0.1%
CZ	1.1%	0.6%
DK	0.3%	0.2%
EE	1.6%	0.8%
FI	0.5%	0.4%
FR	0.4%	0.4%
DE	0.6%	0.7%
EL	1.0%	0.8%
HU	1.2%	1.1%
IE	0.5%	0.5%
IT	0.5%	0.6%
LV	1.1%	1.0%
LT	1.0%	0.8%
LU	0.5%	0.6%
MT	0.3%	-0.2%
NL	0.3%	0.4%
PL	1.2%	1.0%
PT	0.9%	0.8%
RO	0.9%	0.8%
SK	1.2%	1.1%
SI	0.9%	0.7%
ES	0.7%	0.7%
SE	0.7%	0.7%
UK	0.5%	0.5%

Source: PRIMES/GAINS

Similar to the PRIMES/GAINS model, a scenario was developed with the GEM-E3 model to assess the impact of distributing auctioning rights between Member States. Two scenarios where developed:

- Proportional to the cost efficient outcome: Each Member State may auction proportional to its projected emissions in the EU ETS in the cost efficient case.

- GDP modulated: Proportional to 2005 EU ETS but modulated according to GDP with the same redistribution as presented in Table 10.

The overall GDP impact of redistributing the auctioning rights at the EU level is nil (the result is even minimally positive from -0.35% loss in GDP to -0.34%). Also the value of the allowances does not change. All Member States with a GDP per capita below EU average receive more auctioning rights than the amount their installations are expected to need to acquire under the cost efficient case, with the exception of Latvia and Spain. GDP impacts are very small for the richer Member States. For the Member States with a GDP per capita below EU average they are larger and mixed. Instead there is a substantial increase in private consumption in all these Member States with the exception of Spain and Lithuania.

This relatively mixed effect on GDP and high positive effect on private consumption in this GEM-E3 scenario is due to the fact that the redistribution of auctioning rights is recycled through a lump sum transfer to households. Given that GEM-E3 is a general equilibrium model that assumes perfect markets this is translated in a net increase in private consumption and a reduction of the supply of labour, as such also resulting in a net decrease in employment in the model for the Member States with lower GDP per capita. Of course, if the recycling of auctioning rights would not happen through a lump sum transfer to households but for instance by decreasing corporate tax rates, the positive effects for these Member States would be stronger on GDP growth and less strong on private consumption. For the richer Member States the macro economic effects tend to be very small.

This result confirms that redistribution of the allowances within the ETS has no overall efficiency cost at the EU level because of one integrated ETS market. It can compensate member states with a GDP per capita below EU average for their relative greater effort. Depending on the type of recycling applied, this positive effect will impact GDP or private consumption.

Table 13: Macro economic impacts of distribution of auctioning rights taking into account GDP/Capita

	Cost efficient case with auctioning in all EU ETS and no revenue generation in the Non-ETS			Cost efficient case with auctioning in the EU ETS and distribution auctioning rights taking into account GDP/capita and no revenue generation in the non-ETS			
Compa-red to base-line	Change GDP 2020	Change Private Consumption 2020	Change employ-ment 2020	Change in right to auction compared to emissions in cost effective case	Change GDP 2020	Change Private Consumption 2020	Change employ-ment 2020
EU	-0.35%	0.19%	-0.04%	0%	-0.34%	0.21%	-0.09%
AT	0.0%	0.3%	0.4%	-21%	0.0%	0.1%	0.5%
BE	-0.4%	0.2%	0.0%	-10%	-0.4%	0.1%	0.0%
BG	-2.4%	1.3%	-0.5%	48%	-2.1%	7.2%	-0.8%
CZ	-1.7%	0.2%	-0.7%	37%	-2.0%	6.2%	-1.6%
DK	-0.1%	-0.1%	0.4%	-3%	-0.1%	-0.1%	0.4%
EE	-2.3%	-0.4%	-1.1%	54%	-3.1%	8.2%	-2.4%
FI	-0.6%	0.4%	-0.3%	-1%	-0.6%	0.4%	-0.3%
FR	-0.3%	0.1%	0.0%	-27%	-0.3%	0.0%	0.0%
DE	-0.3%	0.1%	-0.1%	-8%	-0.3%	0.0%	-0.1%
EL	-0.8%	-0.2%	-0.3%	22%	-0.8%	0.9%	-0.4%
HU	-1.5%	-0.8%	-0.4%	8%	-1.5%	-0.4%	-0.5%
IE	0.2%	-0.1%	1.3%	-4%	0.2%	-0.1%	1.3%
IT	-0.1%	0.5%	0.3%	-18%	-0.1%	0.3%	0.3%
LV	-0.9%	-0.8%	-0.2%	16%	-0.9%	-0.6%	-0.3%
LT	-0.6%	0.9%	-0.5%	-10%	-0.6%	0.5%	-0.5%
NL	-0.4%	0.5%	0.1%	-23%	-0.4%	0.2%	0.1%
PL	-1.5%	-0.8%	-0.7%	27%	-1.5%	1.6%	-0.9%
PT	-0.3%	0.4%	-0.1%	3%	-0.3%	0.5%	-0.1%
RO	-2.4%	1.6%	-0.8%	49%	-2.4%	7.9%	-1.4%
SK	-1.7%	1.3%	-0.8%	20%	-1.8%	2.5%	-1.0%
SI	-0.6%	-0.4%	-0.5%	22%	-0.7%	0.4%	-0.7%
ES	-0.1%	0.7%	0.8%	-15%	0.0%	0.4%	0.9%
SE	-0.2%	0.1%	-0.1%	-18%	-0.2%	0.0%	-0.1%
UK	-0.3%	-0.1%	-0.1%	-17%	-0.3%	-0.2%	-0.1%

Source: GEM-E3 Europe

Conclusion

1. Auctioning tends to have no negative impact on the economy as a whole compared to free allocation. Of course impacts will depend on how the auctioning revenue is recycled into the economy.

2. Recycling of revenues generated through auctioning in the EU ETS have a positive impact on the overall economy: projections indicate that GDP growth, private consumption and employment all could be higher with auctioning than without auctioning for the EU as a whole.

3. Introducing auctioning does not seem to have a substantial impact on the amount of efficient reductions in the EU ETS compared to a situation without auctioning.

4. Auctioning rights that can be generated with increased auctioning are substantial. If all sectors in the EU EUTS would acquire allowances via auctioning and the carbon value is around 40 €, than the allowances auctioned to companies could represent in member states with a low GDP per capita more than 1% of GDP on average.

5. Depending on the option chosen how the distribute the auctioning share, impacts can be substantial on the overall economic cost per Member State. At the EU level distribution of auctioning rights tends to be neutral on the overall economic cost.

6. Sharing the auctioning share for instance on the basis of a differentiation base on GDP/capita, could lower overall economic costs for Member States with a lower GDP per capita, through a reduced impact on their GDP or an increase in private consumption.

5.3.6. GHG reduction commitment, relationship with the flexible mechanisms, i.e. JI/CDM

At present, under the first commitment period of the Kyoto Protocol, Member States and companies within the EU ETS can use certain emission credits[40] generated through JI and CDM for compliance, up to certain maximum levels. Legally and politically, Member States' use of JI and CDM needs to be supplemental to domestic action. It needs to be assessed what impact any use of JI/CDM type of mechanisms would have be on the achievement of the 20% and 30 % GHG and RES commitments.

The impact assessment for the Communication[41] *Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond* demonstrated already the large impact of (un)-limited access to JI/CDM in the case of an independent commitment by modelling such a target in the global GEM E3 model (see **Table 14**). This projection by the global GEM-E3 model estimated that the carbon value needed to be around 44 € if the commitment of -20% GHG reductions would have to be realised internally in the EU. Instead with unlimited reductions outside the EU through JI/CDM, EU emissions would be much closer to baseline development, actually increasing with 4% by 2020 compared to 1990.

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[40] For JI these emission credits are called ERUs (Emission Reduction Units). For CDM these emission credits are called CERs (Certified Emission Reductions).

[41] SEC(2007) 8.

Access to JI/CDM would result in a lower impact on our GDP development and the carbon value would be limited to 4 € per ton $CO_{2\text{-eq.}}$. Of course this would imply that no significant changes in our energy system nor in our GHG emissions would occur. It neither takes into account the impact on the achievability of the 20% RES target that would become more difficult to achieve. As such, none of the objectives of the energy and climate change package would be achieved, i.e. to show leadership on climate change by reducing emissions, to make the EU more energy secure and to make the EU the most competitive economy in the world with respect to energy.

Table 14 Impact of JI/CDM on the achievement of the independent 20% GHG commitment

EU independent commitment of 20% GHG reductions in 2020 compared to 1990		
	No access to JI/CDM	Unlimited reductions through JI/CDM Full
Real GHG reductions (-) in 2020 compared to 1990	-21%	+4%
GDP Baseline 2020 GDP (2005 =100%)	135%	
GDP Impact	-1,4%	-0,3%
Annualised GDP Impact (reduced growth rate)	-0,09%	-0,02%
Carbon Value	44 €	4 €

Source: GEM-E3 Global

Striking a balance between achieving the necessary GHG reductions internally and paying for reductions through JI/CDM will be required. In PRIMES/GAINS three additional scenarios where assessed to give an indication of what level of use of JI/CDM might be considered and what the impacts would be on achieving the GHG reduction commitment internally in the EU and the RES target:

- One scenario assumed allowing JI/CDM up to a level that the carbon price in the EU would equalise across all sectors and Member States to 35 €/t CO_2, both in the EU ETS sectors and those not covered by the EU ETS.

- One scenario assumed allowing JI/CDM up to a level that the carbon price in the EU would equalise across all sectors and Member States to 30 €/t CO_2, both in the EU ETS sectors and those not covered by the EU ETS.

- One scenario that 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. In the non ETS Member States need to achieve the targets as presented in Figure 2. In the non-ETS 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.

The resulting decrease in internal reductions is significant. In case of a carbon price of 30€ in all sectors, the PRIMES/GAINS model projects that the overall emission reduction effort in the period 2005-2020 would reduce with a quarter, from -14.4 to -11% compared to 2005 emissions. The reduction effort would decrease with a third, from -14.4 to -9,3% taking into account the fact that some Member States can achieve their targets in Figure 2 at prices below

30€/t CO2. At the same time, paying for reductions outside the EU through JI/CDM would require the renewables value to increase to ensure that the RES target can be achieved. This of course decreases the beneficial effect of access to JI/CDM on the overall proportional cost to GDP.

Overall the incremental cost of achieving the climate change and energy package would reduce compared to the case where there is no access to JI/CDM. In the case of the 30 € carbon price, overall costs decrease with a fifth to a quarter compared to the cost efficient case with no access to JI/CDM.

Table 15: Example of impact on GHG reductions of limited access to JI/CDM type of mechanisms for the independent GHG reduction commitment

	Cost efficient case within the EU (no JI/CDM)	Cost efficient case with different levels of JI/CDM		Targets Non ETS modulated with access to JI/CDM
Carbon value in all sectors (€/ton CO2-eq.)	39	35	30	30
Reduction compared to 2005				
All sectors	-14.4%	-12.7%	-11.0%	-9.3%
EU ETS sectors (including outbound aviation)	-17.7%	-15.3%	-13.1%	-12.5%
Existing EU ETS sectors (excluding aviation)	-21.3%	-18.9%	-16.7%	-16.0%
Sectors not covered by the EU ETS	-11.7%	-10.6%	-9.2%	-6.7%
Reduction compared to 1990 for all sectors	-20%	-18.4%	-17%	-15.3%
Renewables value (€/MWh)	45	46	48	49.5
RES share	20.0%	20.0%	20.0%	20.0%
Increased cost of Energy system + cost mitigation Non CO2 + cost JI/CDM credits proportional to GDP in 2020	0.58%	0.53%	0.48%	0.45%

Source: Primes/Gains

Macro-economic effects of allowing part of the reduction commitment to be met by JI/CDM

A similar simulation was carried out with the GEM-E3 model to assess the macro economic impact of the introduction of access to JI/CDM type of mechanisms. It was assumed that 1/5th of the reduction effort compared to baseline in 2020 could be achieved through JI/CDM.

The introduction of reductions outside the EU through JI/CDM reduces at the EU level the impact on GDP, private consumption and employment. The carbon value decreases from 50 € to 30 €. The negative GDP impact by 2020 reduces with more than a third from -0.35% to -.21% of GDP. Employment actually increases beyond the baseline case, even though only marginally to +0.05%. This demonstrates that the recycle effects of auctioning can outweigh the impacts of the reduction effort. The effects on employment and GDP are positive for all Member States while the effects on private consumption are mixed with some Member States experiencing a reduction compared to the case with reductions made within the EU due to the fact that there is less recycling of revenue.

Table 16: Impact of JI/CDM on the macro economic level

Cost efficient case with auctioning in all EU ETS and no revenue generation in the Non-ETS						
	No access to JI/CDM			Achievement of 1/5th of the reduction effort through JI/CDM		
Compared to baseline	Change GDP 2020	Change Private Consumption 2020	Change employ-ment 2020	Change GDP 2020	Change Private Consumption 2020	Change employ-ment 2020
EU	-0.35%	0.19%	-0.04%	-0.21%	0.21%	0.05%
AT	0.0%	0.3%	0.4%	0.1%	0.3%	0.5%
BE	-0.4%	0.2%	0.0%	-0.2%	0.2%	0.0%
BG	-2.4%	1.3%	-0.5%	-1.6%	0.5%	-0.3%
CZ	-1.7%	0.2%	-0.7%	-1.0%	-0.4%	-0.4%
DK	-0.1%	-0.1%	0.4%	0.0%	0.0%	0.4%
EE	-2.3%	-0.4%	-1.1%	-1.6%	-0.8%	-0.7%
FI	-0.6%	0.4%	-0.3%	-0.4%	0.3%	-0.2%
FR	-0.3%	0.1%	0.0%	-0.2%	0.2%	0.0%
DE	-0.3%	0.1%	-0.1%	-0.2%	0.2%	-0.1%
EL	-0.8%	-0.2%	-0.3%	-0.5%	-0.2%	-0.2%
HU	-1.5%	-0.8%	-0.4%	-0.9%	-0.7%	-0.2%
IE	0.2%	-0.1%	1.3%	0.3%	0.0%	1.3%
IT	-0.1%	0.5%	0.3%	0.0%	0.5%	0.3%
LV	-0.9%	-0.8%	-0.2%	-0.6%	-0.5%	-0.2%
LT	-0.6%	0.9%	-0.5%	-0.4%	0.6%	-0.3%
NL	-0.4%	0.5%	0.1%	-0.3%	0.4%	0.1%
PL	-1.5%	-0.8%	-0.7%	-0.9%	-0.9%	-0.4%
PT	-0.3%	0.4%	-0.1%	-0.2%	0.4%	0.0%
RO	-2.4%	1.6%	-0.8%	-1.6%	0.8%	-0.5%
SK	-1.7%	1.3%	-0.8%	-1.1%	0.8%	-0.5%
SI	-0.6%	-0.4%	-0.5%	-0.4%	-0.3%	-0.4%
ES	-0.1%	0.7%	0.8%	0.1%	0.6%	0.9%
SE	-0.2%	0.1%	-0.1%	-0.2%	0.2%	-0.1%
UK	-0.3%	-0.1%	-0.1%	-0.2%	0.1%	0.0%

Source: GEM-E3 Europe

JI/CDM limits and relationship to the EU ETS in the second trading period (2008-2012)

The import and use of JI/CDM credits allows companies to make use of additional cost-effective abatement measures outside Europe thereby lowering the carbon price. At the same time this 'outsourcing' results in lower emission reductions in Europe. For the second trading period of the EU ETS an import of more than 13 % of JI/CDM credits on top of the cap is allowed. This means that companies under the EU ETS could in theory emit 13 % more than what is allowed under the EU-wide phase 2 cap. While such a development is unlikely it is, however, possible that companies nevertheless use the full import allowance. If JI/CDM credits are used to cover EU ETS emissions in 2008 to 2012 the unused allowances could be carried forward (banked) into the third trading period.

Increasing regulatory certainty in the coming years together with higher reduction targets for the period after 2012 is likely to create incentives for companies to reduce emissions already in the second trading period and build up a bank of allowances. The full use of JI/CDM credits in the second phase would further increase such an allowance bank. The more allowances are banked into the third trading period, the lower the effective emission reductions will be between 2012 and 2020.

While much uncertainty exist at this stage about the effective supply of JI/CDM credits in the second trading period, the carbon price and the effect of expectations of a more stringent EU-wide phase 3 cap up to 2020, the described effect is analysed by assuming a certain amount of EU ETS emissions in the period 2008-2012.

If installations under the EU ETS succeed in limiting their emissions in the second trading period to the level of 2005 emissions (i.e. some 6.5 % higher than the phase 2 cap), less then half of the JI/CDM import allowance would be needed for compliance purposes in 2008 to 2012. If nevertheless the remaining part would be consumed, a substantial amount of allowances could be banked. These banked allowances would add to the supply of allowances after 2012, thereby substantially reducing the need for emission reductions achieved by 2020 compared to 2005 emissions levels.

If, e.g., the EU-wide ETS cap would be set at 21% below 2005 emission levels by 2020 than, excluding any demand from aviation, banking of allowances resulting from a full exploitation of the JI/CDM import allowance during the period 2008-2012 could lower the emission reduction effort in the EU ETS by 2020 with a quarter, assuming that banked allowances are consumed at an equal rate in the period 2013-2020.

If emissions in the second trading period would be lower than 2005 emissions levels, the described effect would be further magnified and the reduction effort by 2020 would be even lower. Due to the incentives created by the carbon price it seems likely that emissions in 2008 to 2012 will be lower than 2005 emissions levels.

Conclusion

- Allowing reductions outside the EU via JI/CDM to count towards the independent 20% reduction commitment reduces the emission reductions achieved in the EU. Unrestricted use of JI/CDM could lead to almost no real reductions in the EU. Furthermore, allowing reductions outside the EU via JI/CDM would not render the EU more energy secure, would not result in an acceleration of innovation in the energy and industrial sector and would not give a competitive advantage in an increasingly carbon constrained world.

- Allowing reductions outside the EU via JI/CDM would require that additional RES incentives are put in place to achieve the EU RES target. Even though the cost to achieve the RES target is expected to increase, overall economic costs are projected to decrease by allowing reductions outside the EU via JI/CDM.

- In order to ensure that sufficient effective reductions take place up to 2020, a limit on the use of reductions outside the EU via JI/CDM is necessary. The existing limit on the use on JI/CDM in the 2nd trading period of the EU ETS could have already a large impact on the period after 2012 due to the possibility to bank indirectly excess allowances.

5.3.7. The EU's 30% reduction target in case of an international agreement

The Commission's Communication Limiting Global Climate Change to 2 degrees Celsius had proposed that the EU would pursue in the context of the international negotiations the objective of a 30 % reduction in GHG by developed countries by 2020 compared to 1990 levels together with a substantial broadening of participation by the developing countries. The Council has endorsed this principle endorsing a 30% GHG reduction by 2020 compared to 1990 as its contribution to a post 2012 agreement provided that other developed countries commit themselves to comparable emission reductions.

The 20% and 30% GHG reduction targets take place in a totally different context. In the former, the EU is acting on its own in period after 2012. In the latter the global community is acting on climate change. As such relative prices for energy sources and credits from JI/CDM could differ. Furthermore, in a global framework, there is more of a case to allow the increased use of reductions outside the EU via JI/CDM. Prices for JI/CDM are expected to be higher with a multilateral commitment to reduce emissions, as such ensuring that still sufficient internal reductions in the EU take place.

The POLES global energy model was used to asses the difference between an independent GHG reduction commitment for the EU of -20% with reductions within the EU with no access to JI/CDM and a multilateral target where the EU as well as the group of developed countries collectively would take on a target of -30% GHG reduction and where access to JI/CDM is unrestriced[42].

Figure 3 depicts the possible impact of two different targets on the EU energy mix. In both cases this energy mix changes to an almost identical extent. The use of natural gas would be 1% less in case of the multilateral target, due to increase use globally of natural gas in the case of a multilateral target and thus increased relative prices. The use of coal would actually be 2,4% higher in the case of a multilateral target due to a relative cheaper price for coal but this is compensated to some extend to an increased use of CCS in the EU by 2020 (see also **Table 17**). The use of the other energy sources is almost identical between the independent and the multilateral targets.

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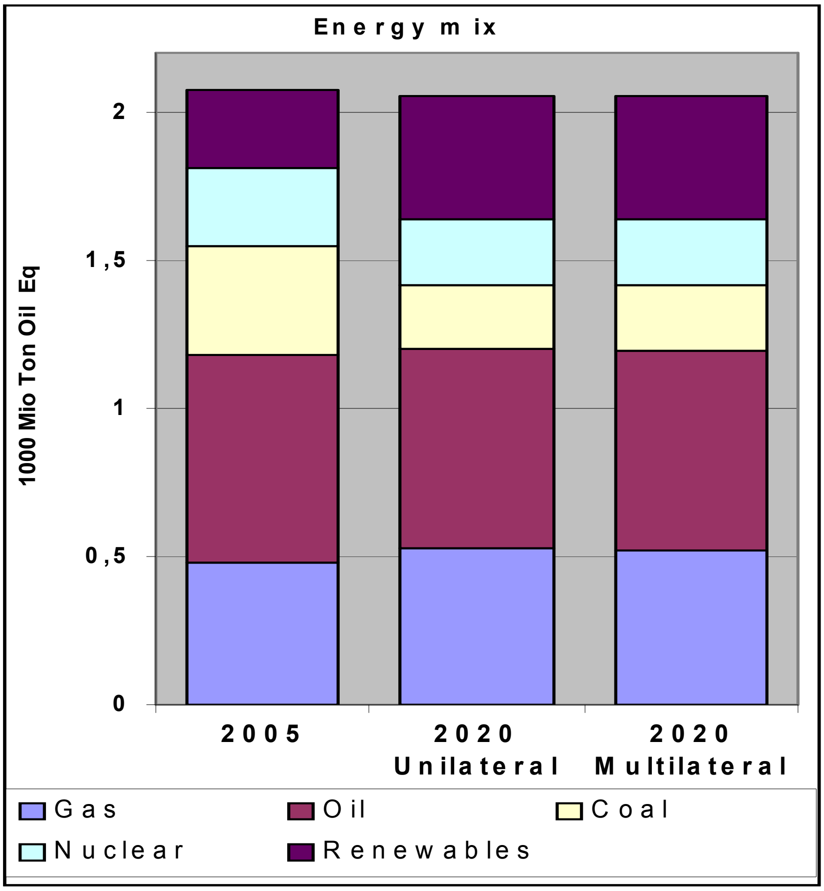
[42] There are no quantitative restrictions on the use of JI/CDM but the POLES model does assume only a gradual development of the global carbon market. For more information see also 'Global Climate Policy Scenarios for 2030 and beyond – Analysis of Greenhouse Gas Emission Reduction Pathway Scenarios with the POLES and GEM-E3 models', Peter Russ, Tobias Wiesenthal, Denise van Regemorter, Juan Carlos Ciscar , EUR Number: 23032 EN, Publication date: 12/200.

Figure 3: Impact of independent 20% GHG reduction commitment or 30% multilateral target on EU energy mix:



Source: POLES-IPTS

Table 17 presents the CO_2 reductions from energy use in the different sector compared to 2005 emission levels. The independent and the multilateral target appear to imply similar emission reduction in the various sectors

Table 17: Impact of independent 20% GHG reduction commitment or 30% multilateral target on the EU CO2 emission reductions profile

Impact of independent 20% GHG reduction commitment or 30% multilateral target on the EU CO2 emission reductions profile		
	independent 20%	Multilateral 30%
JI/CDM	None	Unlimited
	Reduction compared to 2005	
Total Emissions	-16.5%	-16.5%
Power Sector	-27.7%	-27.2%
Other conversion energy	7.3%	6.7%
Industry	-22.5%	-22.6%
Transport	5.5%	5.3%
Residential, services	-10.0%	-10.3%
Share Emissions Power sector Sequestrated through CCS	7.4%	7.6%

Source: POLES-IPTS

Even though these projections indicate that the type of changes expected in the EU's energy system are comparable between the 20% independent commitment and the 30% multilateral target, there is a big difference in the amount of investments outside of the EU energy system through the use of JI/CDM. With a 30% reduction effort, roughly a third of the reduction effort will need to take place outside of the EU and this will of course also have a cost attached.

To assess this cost a similar scenario was calculated using the GEM-E3 global model. This model projects also a very similar reduction profile within the EU both in case of the unilateral and the multilateral target (see **Table 18**). But the major difference is the cost. Even though the carbon value might be lower in the multilateral case due to access to JI/CDM, the overall economic impact on GDP is still twice as high even by 2020. This is due to an overall price increase of low carbon energy sources and the requirement that around a third of the reduction effort needs to be compensated through investments in JI/CDM outside of the EU.

Table 18 EU independent 20% GHG commitment or multilateral 30% target

Impact of - EU independent commitment of 20% GHG reductions in 2020 compared to 1990 - International agreement with EU target of 30% GHG reductions		
EU GHG reduction target	independent -20%	-30% International Agreement
JI-CDM?	None access	Unlimited
Real GHG reductions (-) in 2020 compared to 1990	-21%	-21%
GDP Baseline 2020 GDP (2005 =100%)	135%	
GDP Impact by 2020	-1,4%	-2,8%
Annualised GDP Impact (change in growth rate)	-0,09%	-0,19%
Carbon Value	44 €	31 €

Source: GEM-E3 Global

Conclusion

- The expected impact on our energy system are similar both for an independent GHG reduction commitment of -20% within the EU without access to JI/CDM and a multilateral GHG reduction target of -30% using JI/CDM. The type of changes required to theenergy system could thus be similar. It can be expected that the more JI/CDM enters the EU in case of the independent -20% GHG reduction commitment, the more additional changes will be required to the EU energy system if a multilateral target is agreed upon that would allow the EU to take on the 30% target.

- Overall economic costs do increase in case of the -30% multilateral target. To a large extend this is due to increased costs for JI/CDM. This has of course distributional implications, given that Member States with a low income per capita have less capacity to invest in additional JI/CDM.

5.3.8. Competitiveness issues

5.3.8.1. Introduction

Competitiveness is the performance of firms relative to competitor firms in terms of profitability, market share, production cost, and levels of investment. In the current context, of the IA, competitiveness is used in a more narrow sense, in relation to the performance of firms located in the EU vis à vis third country firms.

The impact of the proposed package 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. The analysis is based on the assumption that third country competitors would not be faced with similar impacts, which is consistent with the situation of an independent 20% GHG reduction commitment and no international agreement and a 20% renewable energy target. Energy intensive industries (EEI) are business entities where the purchase of energy products and electricity amounts to at least 3.0% of the production value[43]. A recent ECFIN study finds that some 50 sub-sectors might require some (more than 0.1 to 5%) increases in prices to recoup costs imposed by an carbon price (of €20/tCO2): 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)[44].

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 appears to be concentrated in a limited number of “genuinely energy intensive industries” ” that are exposed to international competition while not generally affecting manufacturing industry as such.

5.3.8.2. Impact of implementing the GHG and a renewable electricity target

The PACE model (a general equilibrium model combined with electricity sector detail) was used to assess the impact of the 20% GHG target plus a renewable target for electricity of 30% (consistent with the 20% renewable target). In PACE, energy intensive activities exposed to international competition are sub-sectors of the aggregate sectors featured in the ETS, namely ferrous metals, paper products, mineral products, non-ferrous metals, and chemicals. Consequently, sector-specific measures addressed towards energy intensive industries are only applied to the respective sector shares that correspond to the relative weight of the energy intensive sub-sectors within the aggregate sectors. In all scenarios MS CO_2 reduction targets and allowances are allocated based on emission reductions at MS level with full flexibility weighted with MS GDP per capita relative to the EU27 average. The

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[43] Energy Products Tax Directive (2003/96 EC, OJ L 283 of 31.10.2003).

[44] "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.

reference scenario is characterised by partial auctioning[45], an efficient system-wide cap for the ETS, regionally differentiated marginal abatement cost for the non-ETS sectors and no access to JI/CDM. Guarantees of origin are tradable across EU member states. Auctioning are recycled to an economic agent representing both the government and households.

Table 19 represents the main results of the implementation of the package. Column 1 represents the scenario that achieves the GHG and a renewable electricity target of 30% cost efficiently in the PACE model, including partial auctioning of ETS allowances. As a result, there is a "carbon leakage", i.e. the increase in emissions outside of the EU above baseline, which is estimated to be approximately 2.5% of EU emissions. Highest impacts are projected in the energy intensive part of the sub-sector of ferrous metals.

Column 2 represents the results in the PACE model if trading of Guarantees of Origin in the electricity sector (see section 4.3.4) is restricted. According to this model, this could further increase electricity prices and consequently impose additional negative impacts on energy (electricity) intensive sectors exposed to international competition and lead to increased carbon leakage.

Access to JI/CDM up to a quarter of the GHG reduction effort reduces substantially the cost of reaching the GHG reduction target, reduces the pressure on CO_2 and electricity prices, has a positive economy-wide effect in terms of welfare losses (-0.5% instead of -0.7%) and significantly improves the output performance of energy intensive industries. Furthermore, it reduces the potential carbon leakage (from 2.5 to less than 1%).

Table 19 Impact of transfers of renewable targets and JI/CDM on sector output in 2020 (% change compared to BAU)

	Reference scenario	Reference scenario + No RES Transfers through GO trade	Reference scenario + Access to CDM up to 25% of reduction effort
	(1)	(2)	(3)
Share renewables (%)	20	22.6	20
Change CO2 emission EU cf to 1990 (%)	-16.8	-16.8	-11.0
Carbon leakage (% of EU's 1990 emissions)	2.5	2.9	0.8
Change global CO2 emission (% of 1990)	+47.0	+47.1	+46.5
CO2 price (€/t CO2)	34.2	34.2	21.0
Electricity price (% change vs BAU 2020)	22.0	30.7	13.9
Welfare loss (% cf to BAU in 2020	-0.69	-0.92	-0.51
Ferrous metals (%)	-8.0	-8.5	-5.4
Paper products (%)	-1.1	-1.3	-0.7
Mineral products (%)	-2.8	-3.0	-1.8
Non-ferrous metals (%)	-6.5	-7.4	-4.2
Chemicals output (%)	-4.3	-4.6	-2.7

Source: Pace

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[45] Partial auctioning is defined through 20% in 2012 plus 10% per annum of allowances for all ETS sectors (i.e. full auctioning by 2020) excluding the power sector, which is fully auctioned throughout the entire period.

Also the PRIMES model was also utilised to look into detail in the expected energy cost impacts for these energy intensive sectors exposed to international competition. **Table 20** shows the expected increases of energy costs compared to baseline. It confirms that these increases are highest in the Iron and Steel (i.e. ferrous metals) sector and that access to CDM can reduce these impacts considerably. The scenario where carbon prices as projected in PRIMES reduce to 30€ due to access to CDM is comparable with the case where 25% of the reductions in 2020 are achieved through CDM (see chapter 5.3.6).

But it should also be noted that these price impacts are limited as compared to overall increase in production costs compared to total production costs (see **Table 21**).

Table 20 Change in energy costs (fuel costs plus energy production costs) per exposed energy intensive sector in 2020 compared to the baseline for the EU-27 to achieve both the GHG and RES target

Energy costs changes in comparison to Baseline in 2020 (%)	Cost efficient scenario	Low access CDM reducing carbon prices to 35€	High access CDM reducing carbon prices to 30€
Iron&steel	18.2%	16.0%	12.5%
Non-ferrous metal	3.9%	3.7%	3.5%
Chemical	6.3%	5.8%	4.9%
Non-metallic minerals of which:	9.2%	7.9%	6.0%
a.cement	8.9%	7.6%	5.7%
b.ceramics	8.8%	7.6%	5.8%
c.glass	8.9%	7.8%	6.1%
Paper and Pulp	14.0%	13.1%	10.5%

Source: Primes

Table 21 Change in the share of energy costs in overall production costsper exposed energy intensive sector in 2020 compared to the baseline for the EU-27 to achieve both the GHG and RES target

Change in share of energy costs in overall production costs comparison to Baseline in 2020 (%)	Cost efficient scenario	Low access CDM reducing carbon prices to 35€	Higher access CDM reducing carbon prices to 30€
Iron&steel	3.7%	3.3%	2.6%
Non-ferrous metal	0.3%	0.2%	0.2%
Chemical	1.5%	1.4%	1.1%
Non-metallic minerals of which:	2.1%	1.8%	1.4%
a.cement	2.3%	2.0%	1.5%
b.ceramics	1.8%	1.6%	1.2%
c.glass	1.3%	1.1%	0.9%
Paper and Pulp	0.6%	0.5%	0.4%

Source: Primes

The GEM-E3 model that was used to assess in chapter 5.3 the different distributional issues at detailed Member States level also indicates that the impact of implementing the greenhouse gas reduction target is higher for energy intensive sectors exposed to international competition than for the other sectors in the economy. In the cost effective case with full auctioning the highest impact was projected for the ferrous and non ferrous sector with a decrease in production of almost 3%. The results is still a significant impact but less outspoken than the results in PACE that also incorporated the impact for a 30% renewable electricity target.

Table 22. Energy intensive sector impact GEME3 with auctioning in 2020

	Impact of achieving the GHG reduction target on energy intensive sectors in GEME3 with full auctioning in 2020
Ferrous and non ferrous metals	-2.7%
Chemical Products	-1.4%
Other energy intensive	-2.0%

Different measures to take into account the impact on energy intensive sectors exposed to international competition

Different *treatments of energy-intensive industries* under the EU ETS were analysed using the PACE model to study the implications of the energy package on international competitiveness:

- *Access to emission reduction projects in third countries such as CDM:* it was assumed that 25% of the reduction effort could be achieved through the use of CDM.

- *Global Sectoral Agreement (GSA)*: it was assumed that this would cover 80 percent of global production for the respective energy intensive industry. The sectoral agreements reflect a positive contribution of the US and other OECD countries as well as the major emerging economies in the global effort to reduce GHG emissions. However, it is not assumed that these regions commit themselves to reduce their emissions by a certain percentage, but rather express a certain "willingness to pay" concerning the marginal abatement cost i.e a marginal abatement cost of 20 €/tCO_2 for the US and other OECD countries and 15 €/tCO_2 for China, India, Brazil and Russia. Imposing the maximum marginal abatement cost will then induce the reduction in terms of energy intensity for the respective world regions.

- *Free allocation on the basis of benchmarks for EII:* For the energy intensive sectors exposed to international competition free allocation on the basis of benchmarks was assumed. For the other sectors covered under the EU ETS the degree of grandfathering is 50 percent in 2013 and is reduced by 10 percent per year (i.e. full auctioning as of 2018).

- *Free allocation for indirect emissions:* The fraction of allowances allocated free of charge to energy intensive sectors exposed to international competition takes into account to some extent the indirect costs of CO_2 policies in upstream industries. Increased electricity prices, for example, increase the costs of production in EII due to the high CO_2 intensity in the electricity sector. The concerned industries receive an additional free allowance allocation equivalent to the CO_2 emissions embodied in their electricity input.

- *Inclusion of importers:* Importers are integrated in the EU ETS for those energy intensive sectors exposed to international competition. In inclusion in the EU ETS depends on the average CO_2 intensity of the concerned EU sectors and the share of allowances allocated for free. Importers would have to buy allowances in the ETS.

Table 21 summarizes the effects of the possible sector specific measures. *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 21** 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.

Table 23 Impact of sector specific measures to compensate loss of competitiveness

	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**
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 (%change vs 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

5.3.9. Indirect Impacts and Co-benefits

5.3.9.1. Impacts air pollution, costs and benefits

Reducing greenhouse gas emissions and increasing renewable energy has other beneficial impacts such as on air pollution (sulphur dioxide, nitrogen oxide and particulate matter). A policy that reduces greenhouse gases emissions by 20% compared to 1990 while increasing the share of renewables in final energy consumption to 20% would promote energy efficiency indirectly through the increase in energy prices and prompt a shift towards less carbon-intensive fuels, resulting in a corresponding reduction in air pollution. The exact impact depend on the reduction in fossil fuel consumption, the fuel shift induced and the (pollution control) technologies being implemented already (under current legislation) to control air pollution

The impacts on air pollution, air pollution control costs and the environment were estimated using the GAINS model. This model combines information on fuel use per sector with emission per activity and fuel use for each Member State with information on pollution control technology in place with current EU and national legislation. The GAINS model was linked with the PRIMES model to assess the air pollution implications.

Table 24 gives an overview of the impact through reductions of other pollutants of meeting the 20% GHG and 20% renewable commitment. A policy that meets the 20% GHG and 20% renewable commitment in the EU27 in a cost efficient manner would reduce CO2 emissions by around 17% and in addition will reduce SO2 emissions, NOX emissions and small particles (PM2.5) by 10 to 15% mainly since fossil fuel consumption is reduced and shifted to less polluting fuels. These emission reductions reduce the area of forests exposed to high levels of acidification and nitrogen.

In addition, the health benefits due to the reduction in particles would reduce the number of life years lost some 10 million (from 154 to around 142 million) by 2020 depending on the scenario. Premature deaths due to ozone would be reduced by around 800 cases (e.g. from 19399 to 18569 cases per year (efficient case versus BAU)). In addition, sickness (increases cough, hospitalization etc) would be reduced. If the mortality impacts are monetized using standard methods the benefits of the 20% GHG and 20% renewable policy would be between €550 to 1350 billion/year (depending on the valuation and the policy option). The policy options would also reduce ecosystem areas being acidified or exposed to excessive nitrogen loads.

The reduction in air pollution emissions also implies a reduction in pollution control costs. Less fossil fuel fired plants need to be build and hence no pollution control equipment needs to be installed for these plants although new biomass plants might require additional equipment (see Annex 10 for more details by Member State). The net effect is a reduction in air pollution control costs of around 10 to €11 billion in 2020 compared to Baseline. JI/CDM would lower the reduction in pollution control costs since part (around 1/4th of the reduction in greenhouse gases, including CO2, would not take place within the EU-27, and hence not lead to reduction in traditional air pollutants in the EU-27. As a result the air pollution damage would be reduced but less than without access to JI/CDM.

Table 24 Major air pollution impacts of policy options in 2020 for the EU27

	1	2	3a	3b	4	5
Policy option	BAU	Efficient cas0065	As 1 with access JI/CDM at 35€/tCO2[46]	As 1 with access JI/CDM at 30€/tCO2	GDP Modulated targets RES and Non ETS + full RES transfer + no access to CDM	GDP Modulated targets RES and Non ETS + no RES transfer + no access to CDM
SO2 emissions (1000 ton)	4245	3404	3506	3617	3481	3491
NOX emissions (1000 ton)	6893	6138	6218	6298	6112	6106
PM2.5 emissions (1000 ton)	1256	1175	1190	1204	1185	1184
Air pollution reduction (%cf to BAU in 2020) (Sum SO2, NOX and PM2.5)	0	14	12	10	13	13
Forests with nitrogen above critical loads (1000 km2)	893	871	870	868	869	868
Forest with acidification above critical loads (1000 km2)	130	102	101	101	107	110
Health impacts particle emissions (cumulative mio life years lost)	154	142	142	142	143	143
Premature deaths ozone (cases/year)	19399	18560	18674	18777	18824	18817
Reduction health damage impacts over BAU (€billion/year)[47]		12-28	12-28	12-29	11-26	12-26
Air pollution control costs (€billion/year)	82.7	72.4	73.5	74.5	71.9	71.8
Reduction air pollution control costs (€bn/yr)		10.2	9.2	8.1	10.8	10.8

Source: GAINS except monetized health benefits

In brief, reducing GHG and i.e. CO2 emissions by meeting the independent 20% GHG reduction commitment would significantly reduce air pollution, air pollution damage and would cut air pollution control costs by around €10 to 11 billion in 2020 (Annex 10 gives country details). Allowing JI/CDM (at a price up to a price of €30/tCO2 towards the

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[46] Interpolated between 1 and 2b.

[47] Low and high values for life years lost and statistical life are based on Pye, S., M. Holland, P. Watkiss and D. van Regemorter (2007) Analysis of the Costs and Benefits of Proposed Revisions to the National Emission Ceilings Directive. NEC CBA Report 2. CBA of TSAP and EP target optimisation model runs. AEAt for DGENV (available on request).

independent 20% GHG reduction commitment would be expected to reduce these co-benefits to around €8 billion.

5.3.9.2. Impacts energy supply security

Reducing greenhouse gas emissions and increasing renewable energy, reduces energy consumption and shifts fuel use to domestically produced fuel use. As such it makes the EU less dependent on imports of oil and gas and less dependent on geopolitical factors that affect the supply of these fuels and may affect the price of these fuels. The induced benefits basically equal the avoided negative economic impacts resulting from external energy shocks such as the oil price shocks in the early seventies. Less imports makes the EU less vulnerable for such price changes. The impacts on energy imports were estimated using the PRIMES model.

Table 25 shows the impact of the various options to meet the 20% GHG and 20% renewable commitments compared to the baseline for the EU as a whole. These estimates are based of an oil price of 61$ per barrel of oil in 2020, oil indexed gas prices and a $ to € exchange rate of 1.25. The efficient way of meeting the target would reduce imports of gas and oil by around 48 billion € in 2020 (of which €21 billion for gas and €27 billion for oil). The value of the oil and gas imports saved equals 0.3% of GDP. Hence the EU economy would be less affected by supply disruption and price shocks that might result from the concentration of supply in a limited number of countries. Achieving reduction outside of the EU through JI/CDM cost efficiently (implying all carbon prices in all sectors in the EU to equalise at 35 or 30 €) implies that oil and gas imports are reduced less (import savings €45 bln) and the sensitivity for energy price shocks is reduced to a smaller degree since the lower carbon price implies a negative impact on expected increases in energy efficiency. For option 3 (RES and Non-ETS target GDP modulated with full RES trade) gas and oil import savings would be slightly smaller than option 1. If JI/CDM access would be allowed (option 4) oil and gas imports(in bn€) reduce less since countries that can achieve their targets in the Non-ETS at carbon prices below €30/t CO2 are projected to achieve less GHG reductions and thus less saving in gas and oil imports. Without RES transferability (option 5) the reduction in oil and gas imports could be slightly smaller with €46 bln[48]. Effects will vary from member state to member state depending on their reliance on oil and gas imports (See 8.11 for country details).

Table 25: Reduction in oil and gas imports (bln €)

.	1	2a	2b	3	4	5
	Cost-Efficient GHG and RES targets	As 1 with access JI/CDM at 35€/tCO2	As 1 with access JI/CDM at 34€/tCO2	GDP modulated targets RES and Non ETS + full RES transferability	GDP modulated targets RES and Non ETS + full RES transferability + access to CDM at 30/€ t CO2	GDP Modulated targets RES and Non ETS + no RES transfer + no access to CDM
Gas	21.4	21.7	21.4	19.2	19.4	17.2
Oil	27.3	25.6	23.6	28.0	21.3	28.7

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[48] As noted in Section 6, PRIMES assumes full transferability of GO.

Gas&oil	48.7	47.4	45.0	47.2	40.7	45.9

5.3.9.3. Impacts on generation costs, electricity prices and energy costs per sector

A large fraction of the greenhouse reductions and renewables target will take place in the EU-ETS sector and this will have an impact on the electricity price since the power generation sector represents around 2/3 of the CO_2 emissions in the EU-ETS. **Table 26** indicates that the increase in average costs of electricity generation varies between 23 to 33%. The lowest increase being in the cases with JI/CDM (cases 2a, 2b and 4) and the highest increase with the targets modulated and no GO transferability or access to JI/CDM (5).

Average production cost increases for electricity are smaller than generation costs increases since generation costs constitute only part of the costs (transmission and distribution costs do not change).

It should be note that price increases and cost changes are inflated since the baseline does not assume passing on of opportunity costs of the EU-ETS carbon price (of €22/tCO2) in electricity price whereas the policy options do assume full passing on of carbon prices in electricity prices. This implies that electricity price and costs increases in **Table 26** could be overestimated by a factor two since the current carbon price is around €20/tCO2 in 2008.

Since electricity costs are only part of the energy costs for individual sectors (costs being electricity, other fuels as well as annualized investment costs and O&M costs) the increases in energy costs are more modest. Importantly, for final consumers, increases in unit energy prices are partially compensated by increased energy efficiency. Consequently, total energy costs will increase less than electricity and other energy prices. Energy costs per value added increases most in industry and range from 12.6 to 14.1 %. In the tertiary and transport sector overall cost increases are modest. Energy cost increases are compensated to a large extent by reduced consumption.

Table 26 Change in electricity generation costs, electricity price and energy costs by sector in 2020 compared to the baseline for the EU27

Option.	1	2a	2b	3	4	5
	Cost-Efficient GHG and RES targets	As 1 with access JI/CDM at 35€/tCO2	As 1 with access JI/CDM at 30€/tCO2	GDP modulated targets RES and Non ETS + full RES transferability	GDP modulated targets RES and Non ETS + full RES transferability + access to CDM at 30/€ t CO2	GDP Modulated targets RES and Non ETS + No RES transfer + no access to CDM
Carbon price ETS (€/tCO2)	39	35	30	42	30	47
Carbon price non-ETS (€/tCO2)	39	35	30	38	22	38
Renewable support value (€/MWh)	45	46	48	44	49	52

Average costs electricity generation	28.0%	25.8%	23.0%	30.1%	23.5%	32.7%
Average electricity price	22.6%	20.9%	18.8%	23.7%	19.1%	25.9%
Energy Cost per Value Added Tertiary Sector	1.7%	1.2%	0.8%	2.2%	0.70%	3.0%
Energy Cost per Value Added Industry	12.6%	11.5%	9.6%	13.5%	9.6%	14.3%
Energy Unit Cost of Transport Activity	1.4%	1.4%	1.3%	1.7%	1.2%	1.9%

5.3.9.4. Energy expenditures in relation to household incomes

Meeting the 20% renewables and 20% GHG package will have an impact on annual energy expenditures for private households. In the baseline the average energy costs for per household for the EU would be €2331 per year in 2020. Meeting both targets in the most efficient way would increase costs for households by around 6%: additional annualized investment expenditures, operating and maintenance costs plus other welfare costs (transaction costs) would be slightly higher than savings in fuel use. With JI/CDM the average increase in costs would be lower. Differentiated non-ETS targets by Member State (option 3) the EU average increase in expenditures would not differ from the efficient case. Not allowing RES transfers (option 4) would lead to higher cost increases.

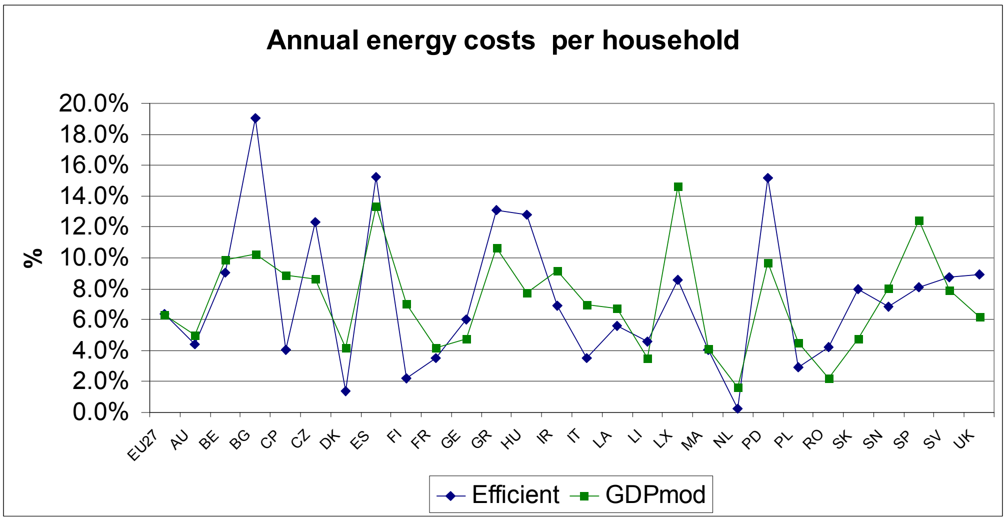
Table 27. Change in energy costs for households in 2020 in EU27

Option.	1	2a	2b	3	4	5
	Cost-Efficient GHG and RES targets	As 1 with access JI/CDM at 35€/tCO2	As 1 with access JI/CDM at 30€/tCO2	GDP modulated targets RES and Non ETS + full RES transferability	GDP modulated targets RES and Non ETS + full RES transferability + access to CDM at 30/€ t CO2	GDP Modulated targets RES and Non ETS + No RES transfer + no access to CDM
€/year	149	130	115	150	104	160
% change over baseline	6.4	5.6	4.9	6.5	4.4	6.8

Note: the above changes include welfare costs in the form of information and transaction costs on top of additional investment costs, O&M expenditures and fuel costs. Without welfare costs cost changes increases would only be around 0.5%.

The changes in energy expenses would not change the expected distribution of energy expenses of households in the various Member States in the baseline significantly. It appears that the efficient case would lead to the highest increase (19%, Bulgaria) and lowest increase (the Netherlands, -1%) compared to BAU. JI/CDM would lower the increases in all countries but not change the (relatively uneven) distribution across member states. Modulating reductions in the non EU-ETS sector according to GDP/capita would lead to a more even distribution of the energy costs increases across households in the various member states (see **Figure 4**).

Figure 4 Energy costs for households by member state in 2020 (€/year)[49]



5.3.9.5. Sensitivity analysis high oil prices

A sensitivity analysis was carried (with the PRIMES model) for the effect of higher energy prices. Two cases were assumed: 1) gas prices that remain linked to high oil prices and 2) gas prices that are decoupled from oil prices. In both cases the oil price is assumed to reach $100/barrel (in 2005 prices) in 2020 compared to $61 in the baseline or some 63% more expensive. For comparison, the average oil price in 2007 amounted to $73/barrel. In case 1 the gas prices increases to $77/barrel oil equivalent (boe)(+80% compared the baseline) and in case 2 the price increase is limited to $59/boe. In both cases the coal prices increase as much as the oil price (some 60% higher than in the baseline in 2020) to $24/boe in case 1 and $23/boe I case 2.

As a result of the higher fuel prices primary RES deployment (in 2020) is expected to increase by 2.4% (case 1) to 1.8%-points (case 2) in terms of gross final energy demand. CO2 emissions from energy would be 7 to 8% lower (7.1% in case 1 and 7.6 % in case 2)(or some 320 MtCO2) than in the baseline in 2020. Instead of a reduction in CO2 emissions from energy of around 17% in 2020 (compared to be baseline) a reduction of only some 10% would only be needed additionally to achieve the GHG target. This implies that the additional efforts needed to achieve the GHG and RES target would be significantly lower.

Higher energy prices would reduce the costs of meeting the RES and GHG targets. For the cost-efficient case the higher oil, gas and coal prices (case 1) imply that annual additional energy system costs would be €32 bn lower in 2020 and only be around €59 bn in 2020. The carbon price would drop to €34.5 per ton and the renewables value to €37/Mwh. That implies that the additional costs of the combined policy package would be around 35% lower than in the baseline case so lowering the cost from 0.61 to around 0.38% of GDP in 2020.

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[49] Welfare losses due to information and transaction costs not included.

It is important to note that this cost reduction for higher energy prices relates to the additional costs of implementing this package. Total energy system costs do rice substantially between a baseline with oil prices of \$61/barrel in 2020 and one with high oil prices of \$100/barrel in 2020 (case 1). This increase in energy system costs in the baseline is equal to €275 bn in 2020.

6. IMPLEMENTING THE RENEWABLE ENERGY OBJECTIVE

The 20% EU commitment was proposed by the Commission in the Renewable Energy Roadmap[50] and endorsed by the Spring 2007 European Council. The impact assessment of the renewable energy roadmap[51] analysed the 20% target for renewable energy. It included the following results on establishing a 20% target for the EU.

Table 28: Summary of impacts at EU level of a 20% renewable energy target for 2020

Impact	20% target*
Cumulative additional production costs (2005-2020) €bn	125-290
Annual average additional costs €bn	13-18
Additional cost in 2020 €bn	0-31
Reduction in GHG (Mt p.a.)	600-900
Reduced fossil fuel Mt	200-300
Δ GDP (%)	-0.05 - 0.5
Δ employment	~ +650,000

* range chiefly reflects oil price range \$48-\$78,

It found that annual CO_2 emissions should fall, that annual fossil fuel demand should fall and that there would be a slightly positive effect on GDP growth resulting from employment and technological/industrial development. IPTS modelling of reaching a 14% biofuels target was also undertaken, suggesting that GDP would be 0.23% higher and 144,000 jobs would be generated (these results depend on oil price and import assumptions)[52].

This impact assessment does not repeat this analysis.

6.1. Accounting method

Effective monitoring of renewable energy targets requires clearly defined and widely accepted statistical methods. It is on the basis of such methods, in addition to high quality data, that National Statistical Authorities will be called upon to report on the attainment of targets. Traditionally, the "energy balance" of a Member State has been the reference which provides

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[50] COM(2006) 848.

[51] SEC(2006) 1719, pp. 17-21.

[52] Institute for Prospective Technology Studies (IPTS) European Commission (2006): "Prospects for agricultural markets and income 2006-2013" http://ec.europa.eu/agriculture/publi/caprep/prospects2006/index_en.htm and EUCAR, Concawe and European Commission Joint Research Centre (2006), "Well-to-wheels analysis of future automotive fuels and powertrains in the European context, version 2b"; http://ies.jrc.cec.eu.int/wtw.html. More recent research highlights the positive employment effect expected from the growth of this industry: employment in the renewables sector in grew by 50% between 2004 and 2006, to 235.000, with this expected to reach 400.000 by 2020 (RENEWABLE ENERGY: EMPLOYMENT EFFECTS Impact of the Expansion of Renewable Energy on the German Labour Market Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) www.erneuerbare-energien.de).

statistics for evaluating numerous energy policies and indicators (security of supply, energy efficiency, renewable energy, fuel mix etc).

In the discussions on renewable energy targets leading to the decision of the European Council in March 2007, concerns were expressed that the choice of accounting method could lead to undesirable discrimination between the various sources of renewable energy. In particular, accounting in primary energy could result in favoured treatment of renewables used in combustion technologies (biomass) compared to technologies with no conversion factors (such as wind energy).

The three accounting methods are assessed below in light of their treatment of different types of renewable energy, methodological validity and acceptability and consistency with existing legal practice.

Primary energy (Eurostat method)

The Eurostat method results in significant discrimination for and against certain types of technology. Nuclear energy, due to an agreement of the 1980s, counts for three times more in primary energy than in final, whilst wind, hydro and photovoltaic power count equally in final and in primary.

This accounting also leads to discrimination against wind energy, hydro power and photovoltaic power relative to biomass, geothermal and solar thermal energy. In addition, whilst EU policy discussions of renewable energy targets have historically used primary energy, the legal basis used in Directives 2001/77 and 2003/30 does not. Requiring the measurement of targets in terms of primary energy would thus require a change from the current legal approach.

As noted above, primary energy gives greater weight to thermal and nuclear energy. Thus increases in the proportion of thermal and nuclear energy in the energy mix will make the achievement of any given renewable energy share harder to achieve.

For these reasons, the use of the Eurostat method is not supported.

Primary energy (substitution method)

The substitution method solves the problem of discrimination identified with the Eurostat method. It gives an appropriate valuation to energy from wind, hydro and photovoltaic power.

However, it has the disadvantage of requiring the use of a hypothetical reference case: that of a hypothetical conventional thermal power station. Either the efficiency of the hypothetical reference case must be kept the same over time (introducing an ever greater deviation from reality); or it must be made to change (introducing uncertainty and the placing of a shifting value on the contribution of the same quantity of renewable energy).

For these reasons, Eurostat, the IEA and most of Member States do not use the substitution method. The use of the substitution method would therefore raise a problem of compatibility with the 20% renewable energy target in the renewable energy roadmap.

For these reasons, the use of the substitution method is not supported.

Final energy consumption

The final energy consumption method overcomes the main disadvantages of the Eurostat method (discrimination between types of renewable energy) and of the substitution method (reliance on a hypothetical reference case). In addition, consistency is maintained with the accounting methods used under existing legal texts (Directives 2001/77 and 2003/30).

As noted above, final energy consumption avoids the discrimination against certain types of renewable energy, and lowers the weighting of thermal and nuclear energy. This method is neutral to the composition of non-renewables energy supply as it does not consider transformation losses in power generation, which are substantial for nuclear and most fossil fuel power generation.

The final energy consumption method has the disadvantage that energy efficiency improvements in energy transformation will not be taken into account.

This disadvantage is considered to be less important than the disadvantages of the two primary energy methods. For that reason, the use of the final energy consumption method is recommended.

If the final energy consumption approach is adopted, overall national shares for renewable energy could be defined as:

$$\frac{\textit{(Gross production of renewable electricity + renewable energy for transport + heat produced from renewable energy)}}{\textit{Gross Final Energy Consumption}^{53}}$$

The national renewable energy targets using the above way of calculation would also include any imported renewable energy, which would be considered equivalent to production when accompanied by a Guarantee of Origin. In a further development (see under 5.3.3), this could also include virtual trade.

6.2. Sharing the 20% renewable energy target among Member States

The options assessed are:

a) sharing on the basis of Member States' national resource potential;

b) sharing on the basis of a flat-rate increase in the share of renewable energy (measured in percentage points) in each Member State weighted by GDP and modulated to take account of earlier development of renewable resources.

The PRIMES model was used to examine national resource potential and the 2020 targets.

The "potential" option is a cost based optimisation reflecting national resource availability. It reflects principles of economic efficiency, and availability of all renewable energy technologies and does not take into account equity considerations such as differences in wealth between the Member States.

The flat-rate option is intended to provide a simple, common, fair increase for all Member States. When weighted by GDP, the result reflects the wealth of the different Member States,

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[53] The Gross Final Energy Consumption is the final energy consumption including the consumption of the energy sector for electricity and heat generation and distribution losses for the transmission of electricity and derived (network) heat.

and when modulated to take account of early progress in developing renewables, the result recognises the role "early starters" have played in leading the development of renewable energy in Europe.

Applying these weightings and modulations has a significant affect on the national targets. (See 4.3.2 and Annex 6 for calculation details) The results of the two approaches are as follows:

Table 29 Sharing the 20% renewable energy target among Member States, comparing options

Potential %		Increase %
Austria	39	16
Belgium	13	11
Bulgaria	23	13
Cyprus	11	8
Czech Rep.	20	14
Denmark	33	16
Estonia	39	21
Finland	43	15
France	19	9
Germany	16	11
Greece	19	12
Hungary	20	16
Ireland	17	14
Italy	14	9
Latvia	51	16
Lithuania	36	21
Lux.	9	8
Malta	6	6
Netherlands	13	11
Poland	19	12
Portugal	34	13
Romania	26	9
Slovakia	19	12
Slovenia	24	8
Spain	24	16
Sweden	48	8
UK	13	12

Flat rate/GDP %		Increase %
Austria	34	11
Belgium	13	11
Bulgaria	16	7
Cyprus	13	10
Czech Rep.	13	7
Denmark	30	13
Estonia	25	7
Finland	38	10
France	23	13
Germany	18	12
Greece	18	11
Hungary	13	9
Ireland	16	13
Italy	17	12
Latvia	42	7
Lithuania	23	8
Lux.	11	10
Malta	10	10
Netherlands	14	12
Poland	15	8
Portugal	31	11
Romania	24	6
Slovakia	14	7
Slovenia	25	9
Spain	20	11
Sweden	49	10
UK	15	14

Clearly, the two approaches redistribute the national shares. The approaches also have an impact on costs, fossil fuel demand and CO_2 reductions.

Impact on Costs:

Under the "potential" option, it is assumed that the 20% renewable energy target will be fulfilled in an economic efficient manner considering resource availability wherever these occur in the EU. Thus, the scenario developed for the "potential" option estimates how the 20% target could be achieved in a low cost manner considering technology diversity and dynamic context.

The flat rate/GDP option deviates from this principle. It follows that the cost of the policy will rise and that on this criterion, the "potential" option ranks more highly.

In terms of costs, it is unsurprising that the move from an economic allocation based on resource potential to a flat rate allocation should generate additional costs. In the simulation used in this impact assessment this cost difference was estimated by comparing the total cost of policy implementation under the two scenarios. As illustrated in **Table 36**, the costs of achieving the RES targets exactly in the individual MS could amount to up to an extra annual €8bn by 2020.

Such costs would be diminished by increased trade, facilitated by the creation of virtually transferable guarantees of origin (discussed in section 6.4 below), allowing Member States to meet their targets not only through national production but also by buying cheaper production elsewhere.

It should be emphasized that total benefits will depend on a wide range of factors that are difficult to predict ex ante. Overall, it can be concluded that allowing for flexibility around flat rate/ GDP approach targets by enabling trade can lead to cost reductions, which can make the achievement of overall targets more adaptable to uncertain economic, technical and energy developments.

Impact on Emissions:

The choice of target method alters national targets and as well as altering costs, it has a small impact on the technology mix of the composition of renewable energy production up to 2020. Moving from "potential" to the flat rate approach reduces the efficiency of the solution and this is reflected in the rise in the use of more expensive technologies and the fall in the use of cheaper technologies.

Economic impact on different Member States/fairness:

National differences in wealth are quite significant across the EU. Some Member States have GDP/capita less than a fifth of the EU average, some two or three times higher.

Whilst the EU already has policy instruments that address such concerns (cohesion and structural funds, etc, which include funding for the deployment of renewable energy), it remains appropriate that policies with major cost implications, such as the policy of renewable energy promotion, should take national "ability to pay" into account.

Where targets are modulated according to GDP, stronger, wealthier economies receive targets that are moderately higher than under the "potential" approach. Member States with a GDP below the EU average face lower targets, reducing their costs and, where they have significant renewable energy resources, giving them greater scope for earning income through the transfer of guarantees of origin. (Further aspects of such flexibility are covered in 5.3.3)

In moving from a potential approach to a flat rate/GDP approach there is a slight realignment of costs, broadly speaking with wealthier countries costs rising slightly, and poorer countries costs declining. Overall, on this criterion, the flat rate/GDP option ranks more highly.

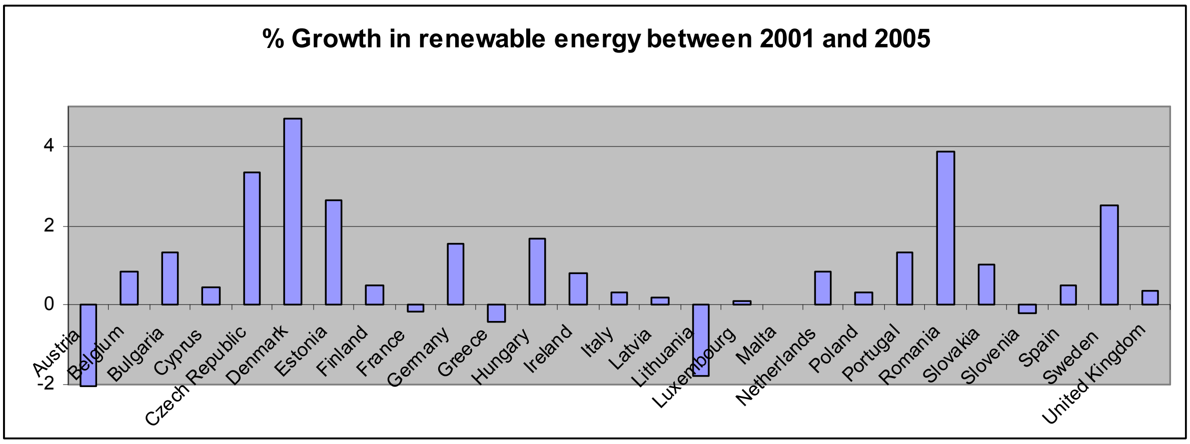
Reflection of different national starting points:

In principle, this criterion favours the "potential" option, as it is likely that the renewable energy opportunities exploited by "early starters" are the cheapest. Thus remaining potential will tend to have higher unit costs than the potential of countries that have not yet begun to exploit these cheap opportunities. The potential approach takes this factor into account implicitly; the flat rate/GDP option (taking 2005 as the starting point for the calculation of flat-rate increases, as described in Annex 6

) is explicitly modulated to take it into account.

This is done by examining the growth in renewable energy shares between 2001 (when the first European renewable energy legislation was adopted) and 2005 and for those Member States with growth of more than 2% a deduction of one third of the difference is granted. This approach is preferable to taking an earlier base year as there is a need to maintain consistency with the greenhouse gas analysis (which takes 2005 as the base year), 2005 data is more reliable and because some Member States have *less* renewable energy in 2005 compared with 2001, and thus would be penalised by moving to an earlier base year.

Figure 5 % differences in renewable energy shares between 2001 and 2005



Source: Eurostat Data in Focus 19/2007 (in Final energy, normalised).

Reflection of national resource potential:

This criterion naturally favours the "potential" option. This determines targets drawing on a detailed database of each Member States' resource potential and costs. However, the overall resource potential of the EU is also incorporated into the flat rate/GDP approach and acts as a control factor in this method. Thus, the results of the flat rate/GDP option do not deviate significantly from those that a pure potential approach would give. The ability to exploit renewable energy potential cost effectively is also facilitated by the creation of transferable guarantees of origin (see section 6.4).

Reflection of national energy mix:

This criterion is addressed with the choice of accounting method (final energy consumption) and the two options discussed here do not affect the result.

Conclusion

The analysis above suggests that the setting of national targets based on resource potential would cost less than an approach based on a flat rate/GDP method.

The approach based on a flat rate/GDP weighting does not reflect *national* resource potential and thus is necessarily a more costly approach, but the fairer distribution of the costs of achieving the overall target imply that it is a more feasible approach.

Finally, the higher costs of the flat rate/GDP approach can be mitigated through trade in renewable energy. The development of an effective transferable GO regime which can ensure that resource potential is developed and contributes to reaching the EU targets irrespective of its national location is discussed in section 6.4 below.

Thus, if a cost effective mechanism for reaching the EU targets through the efficient exploitation of resource potential is possible in combination with the flat rate/GDP approach to target setting, goals of fairness and cost effectiveness can be reached simultaneously.

6.3. Improving the guarantees of origin regime

Directive 2001/77 on green electricity provides minimum requirements for the implementation of GO systems in Member States, thereby leaving the majority of design features to each Member State. As a result, the GO systems implemented in the Member States have different formats. There are currently differences in the size or face value of the GO, its validity period, and the frequency of issuing the GO. Some Member States have designed their GO systems to include key aspects like electronic issuance, transferability, marking for support received and redemption, whereas other Member States have not. In addition to these differences, the procedures (e.g. qualifying and inspection criteria for accreditation of eligible production plants, code of practice for auditing and auditing frequencies, etc.) under which the GO is issued also vary.

The use of GOs for facilitating trade in renewable energy has been studied extensively[54] since the regime's introduction. A number of recommendations have been highlighted that would improve the design of the GO, on a standardised basis.

A standardised, more reliable and robust GO will help to increase market transparency, encourage greater participation and trade, and facilitate Member States' efforts in achieving their national targets in a more cost-efficient manner.

The following table provides an overview of design features that could be introduced to increase the reliability and robustness of the GO. These design features are the result of different studies co-financed by the Commission and previous stakeholder consultation exercises. It also provides a summary of the advantages and disadvantages of introducing these additional features.

Table 30: Summary of possible design features to strengthen the GO regime, and their advantages and disadvantages.

Additional design feature	Advantages	Disadvantages
Electronic issuance	Enables easy and reliable cross border transfers of GO, reduces the potential for fraud and multiple counting	High initial system costs.
Redemption	Reduces the potential for fraud and	Increases cost of system

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[54] The RE-GO project "Renewable Energy Guarantees of Origin: implementation, interaction and utilization", European Commission Contract No: 4.1030/C/02-025/2002, the E-TRACK project "A European Standard for the tracking of electricity", European Commission Contract No: EIE/04/141/S07.38594 and the PROGRESS project "Promotion and growth of renewable energy sources and systems", European Commission Contract No: TREN/D1/42-2005/S07.56988.

	multiple counting	(marginally)
Standard size or face value, e.g. 1 MWh	Improves ease of transfer of GOs	Some Member States currently use different sizes
Standard validity period, e.g. 2 years	Helps reporting use, improves ease of transfer of GO, reduces the potential for fraud and multiple counting	Could create administrative problems if linked to national supports schemes having other accountancy features
Standard issuing frequency.	Helps reporting use, improves ease of transfer of GO, reduces the potential for fraud and multiple counting	Could create administrative problems if linked to national supports schemes having other accountancy features
Single registry in each Member State (or each non-overlapping geographical area within a country)	Reduces the potential for fraud and multiple counting	None
Interfaces between Member States registries	Enables easy and reliable cross border transfers of GO, reduces the potential for fraud and multiple counting	High initial system costs.
Full tracking of GO from issuance to redemption, including transfers in a register	Enables easy and reliable cross border transfers of GO, reduces the potential of fraud and multiple counting	High initial system costs.
Standardised information content of the GO, including: -Year of construction - Support received	Helps reporting use, improves ease of transfer of GO, reduces the potential for fraud and multiple counting, allows the market to differentiate support to plants depending on construction year, thereby reducing above normal profits	High initial system costs.

Impact on costs

It should be noted that a more sophisticated and detailed GO system, with additional features as illustrated in the table above, would imply higher administrative costs.

The costs of a guarantee of origin regime include the development and operation costs of a registry as well as costs of plant registration and audits and transaction costs for participants. The tables below provide a list of cost drivers for a guarantee of origin regime. Most of these can be considered as administrative costs.

List of cost drivers for tracking systems – system level

Cost drivers for system development and implementation	**Cost drivers for system operation and adaptation**
Setting up organisational structures	Governance of the overall system
Composing detailed system specifications	Operation and maintenance of the system (hardware maintenance, software maintenance)
Software development/development of a registry	User support
Collection of initial data input	Further development of the system due to user needs and policy development

Testing of registry	
Organisation of data input	
Development of interfaces between registries	
Composing information material for users	
Training of market actors	

Source: Final report from E-TRACK project

List of cost drivers for tracking systems – operational level

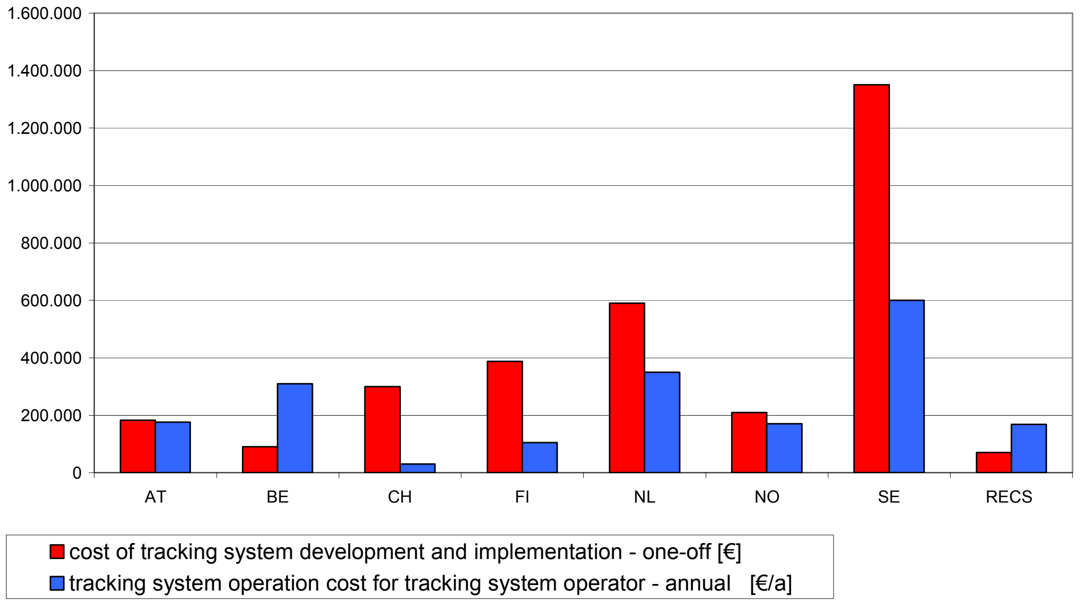
Cost drivers for handling of tracking data	
Issuing aspects:	Transfer aspects:
Certification and auditing of plants	Handling of information (certificate) transfer
Collection of plant master data	Usage and redemption aspects:
Collection of generation data	Conversion of data into format for final use (e.g. for disclosure)
Verification of input data	Verification of output data
	Calculation of residual mix

Source: Final report from E-TRACK project

The E-TRACK project has estimated the costs of setting up and operating existing tracking systems. The figure below shows the system development and implementation costs and operational costs from 7 different national guarantees of origin and support scheme registries as well as an estimate for a generic RECS registry.

System costs of existing tracking systems

Figure 6: System costs of existing tracking systems



Source: Investigations of AEA

The figure shows a large range in the system costs of existing tracking schemes. The one-off cost for development and implementation of tracking systems range from below € 100.000 up to more than € 1.3 mill. Similarly, the annual costs for the system operator for the operation of tracking systems differ between € 50.000 per year and up to € 600.000 per year.

It seems that the wide variation in system costs is related to the different levels of policy integration of guarantees of origin. Schemes used for the purpose of disclosure are cheaper than schemes used for managing support schemes, which have more stringent requirements.

The project has estimated that 70% of the system development and implementation costs are, on average, related to the development of registry software. The remaining 30% represents costs for setting up the organisational structure and for training market actors and users. With regard to the operational system costs, some 45% are related to overall maintenance and governance of the system, including ongoing system development and user support. Costs related to plant registration and issuing and those for usage and redemption, including reporting, represent around 25% of the operational system costs, respectively[55].

For an assessment of the likely cost of implementing a guarantee of origin regime[56], three different scenarios[57] have been defined which relate to the framework condition in the respective country[58].

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[55] These figures do not include the costs for the users of the system.

[56] In the E-TRACK project it is referred to as a E-TRACK standard.

[57] Lower scenario: The lower scenario is defined as a standard implementation of the E-TRACK standard under favourable framework conditions. The tracking system is designed for the implementation of

The cost estimates are based on a number of assumptions, which are summarised in the table below.

Assumptions for the cost estimate

	Unit	Lower scenario	Advanced scenario	Upper scenario
Costs of tracking system (per domain)				
Development and implementation	EUR	210.000	650.000	1.490.000
System operation	EUR/a	195.000	400.000	660.000
ntral communication hub				
Development and implementation	EUR	200.000	400.000	1.500.000
System operation	EUR p.a.	150.000	300.000	600.000
nt registration and auditing				
Plant audits per year (29 countries)		2.000	2.000	2.000
Average cost for audit	EUR	300	1.000	2.500
nsaction cost for market participants				
Number of active system users (29 countries)		600	1.200	1.800
Time required for tracking per user	days p.a.	12	24	36
Staff cost	EUR/day	600	600	600

Source: Estimates by AEA

The E-TRACK project has calculated the cost of electricity tracking systems in EU27 and Norway and Switzerland. The project has illustrated the expected range of costs under the conditions described for three electricity tracking scenarios of differing levels of sophistication and rigour. Annualised costs are estimated to range between €12M and €71M per year.

It should be noted that these estimates are pessimistic in the sense that they do not assume any learning effect and synergies between existing and new (more reliable and robust) GO systems. It would be safe to assume that the more GO systems are developed and implemented, the lower the costs for the system development and implementation will be. Some systems could simply share the use of registry software with other systems (which is the case today under the European Energy Certificate System (EECS)). The estimate does not assume that countries could decide to join up systems, which would again reduce some of the costs.

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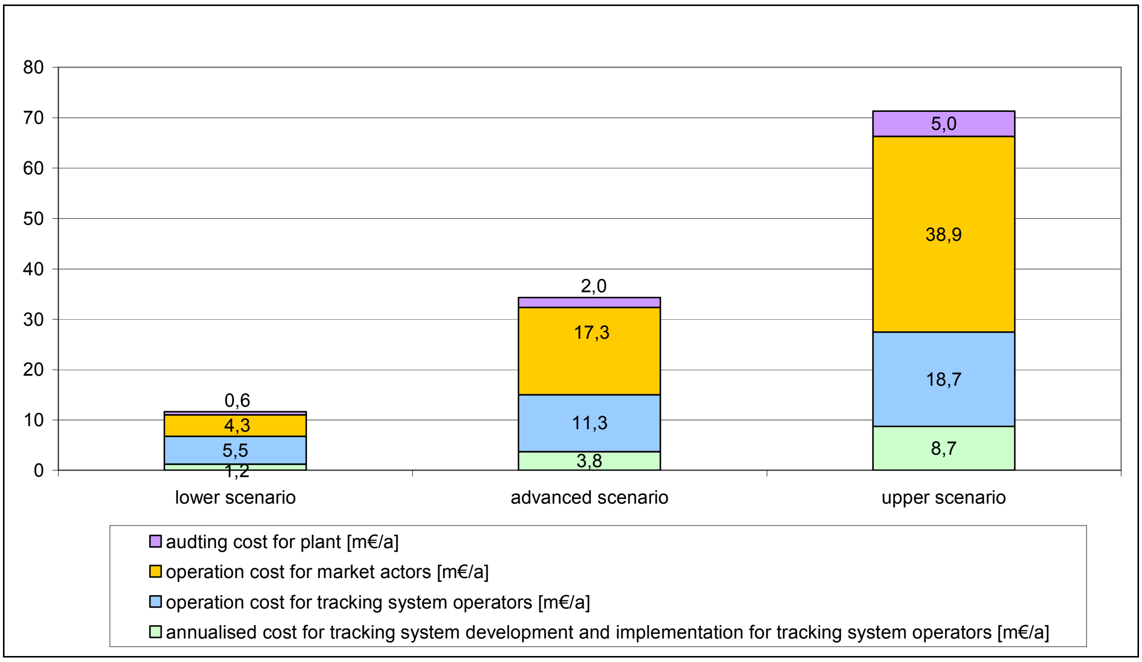
disclosure only, but not for managing support. The domain can rely on existing organisations which will act as issuing body and other service providers. Also, procedures are already in place which can be used for the collection of all relevant data, at least for RES-E and CHP-E generation. Advanced scenario: The advanced scenario is an extension of the lower scenario. Here, new organisations for the implementation and operation of the tracking system have to be set up. Existing procedures can partly be used for electricity tracking. The E-TRACK system is embedded in a more integrated policy framework. Besides being the backbone for disclosure, the E-TRACK system also facilitates support schemes for RES-E. This requires a higher functionality of the tracking system. Upper scenario: The upper scenario is an extension of the advanced scenario. It is assumed that the E-TRACK standard is fully integrated in the policy framework and is the main tool to administrating national RES-E support schemes. So the system requirements for reliability, accuracy and security are very high, which leads to significantly higher cost for system development and operation.

[58] Because the assessment is based on total costs across Europe (EU27 countries plus Norway and Switzerland), each scenario assumes homogenous conditions in all countries. This will of course not be the case in reality. Therefore the results should be seen as marking the band in which the actual cost in Europe for the implementation of the E-TRACK standard will most likely lie.

Figure 7: Expected total annual costs for the E TRACK system in Europe



Source: Final report from the E-TRACK project

As most of the costs can be expected to be passed on to the final consumer, the costs should be related to the total electricity consumption within a Member State system or in Europe as a whole. The figures above can be related to the current wholesale market price for electricity. Compared to the value of physical energy, which currently is in the range between 45 and 55 €/MWh[59], the expected costs for tracking would be in a range from 0,008% to 0,05%.

The costs related to issuing and handling GOs can be compared to the costs of the "first compliance cycle" of the European Emission Trading Scheme (EU ETS). The overall gross and very rough estimate of starting-up the EU ETS scheme, including 10,600 installations, was around € 200M[60]. This includes high costs related to monitoring, and permitting and approval, which are largely one-off, as systems needed to be put in place only once. The operational costs for all parties (Member States, competent authorities and operators) are estimated to around € 100M per year.

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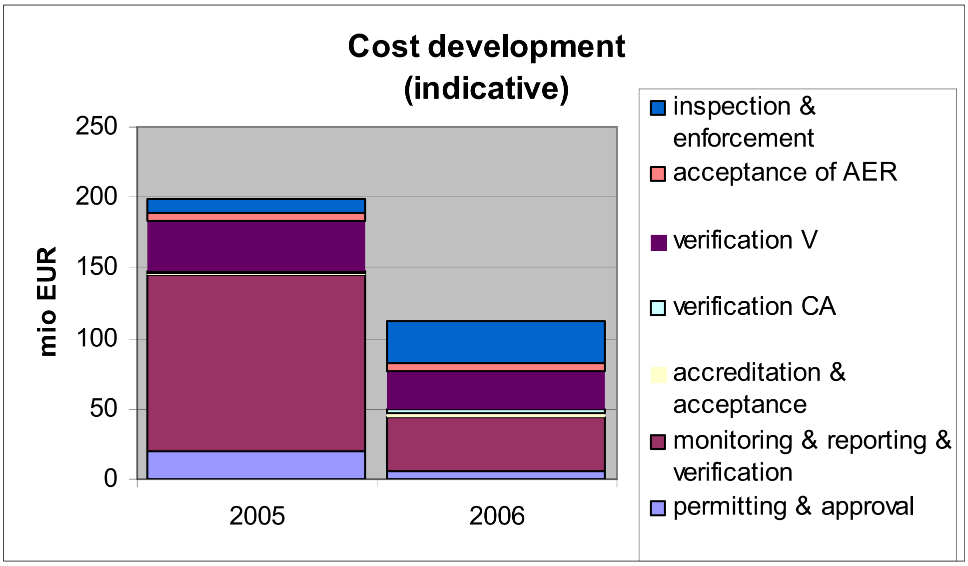
[59] Taken from baseload future prices at EEX and Nordpool power exchanges.

[60] Source: Evaluation of the 1st round verification of the EU-ETS, Utrecht, 2 November 2006, PricewaterhouseCoopers/Ecofys.

Figure 8: Cost developments for the EU ETS (2005-2006)



Source: PricewaterhouseCoopers/Ecofys

It is considered that the benefits of standardisation of GOs in the ways outlined in the table outweigh the costs. The option of standardisation is therefore recommended.

Design details

Three of the above mentioned design features require a numerical value: the size or face value, the validity period and the issuing frequency of the GO.

Validity period

The validity period of GOs currently in existence vary from an infinite validity period to specific validity periods ranging from one to five years. Choosing a short validity period has the advantage of guarantees of origin being quickly removed from the registry, making the operation and revision of the system easier. However, longer validity periods will allow for "banking" of guarantees of origin, which could have a positive effect on reducing price volatility. A validity period of one year could be problematic with regard to different accounting periods in Member States, e.g. the accounting period is 1 April to 30 March the following year in some Member States, and from 1 January to 31 December in others. In order to accommodate differing accounting periods and to reduce price volatility a validity period of three calendar years is proposed.

Q: production date on GO might be sufficient and specification of a validity period unnecessary. To be confirmed.

GO size

The majority of Member States with GO systems in place have chosen 1 MWh as the standard size or face value, reflecting the preferred size for the GO. Alternative face values can be found in Italy (100 MWh) and UK (1 kWh). These alternative sizes could be problematic. 1 kWh GOs would result in a vast number of GOs in a register, whereas the Italian size of 100 MWh would exclude smaller plants. The size preferred by most Member States, namely 1 MWh, therefore seems a sensible way forward.

Issuing frequency

Issuing frequency is also subject to variations between Member States. The most common frequency is issuance on a monthly basis. However, in some Member States the issuance is every third month, yearly basis, or in some cases this is not specified. There is an important trade off between increasing the issuing frequency and the cost of operating the system – the higher the frequency the higher the cost of operating the system. On the other hand, a more frequent issuance has the advantage of allowing shorter transfer periods. It would seem sensible to choose the issuance frequency which is most applied today, which is monthly issuance.

6.4. Virtual trade in renewable energy

Section 5.3.4 recalls that in addition to physical trade in renewable energy, the trade of guarantees of origin can be a way of cost effectively exploiting Europe's renewable energy potential and of reducing the costs of complying with the targets. Section 6.3.3 notes that using a flat rate/GDP approach to setting targets *raises* compliance costs and increases the need for flexibility to ensure the targets are reached cost effectively. For these reasons, the creation and implementation of a transferable guarantee of origin need to be explored.

This section assesses the options of status quo, creating an open "market" for guarantees of origin and creating the framework for trade, open to those Member States who wish to take advantage of the potential cost savings.

The criteria to assess the different options are cost effectiveness, the ability of Member States to reach the targets, the compatibility with support schemes and the internal market, the impact on the functioning of the EU ETS , on long term technological development and on the energy mix.

6.4.1. Option 1: the status quo

Under the status quo, physical trade in renewable energy continues, but no virtual trade in guarantees of origin would occur. Member States could import renewable fuels or power, but compliance with the targets would depend on national consumption of renewable energy.

Impact on Costs

Energy companies or Member States themselves will have to meet their renewable energy targets through national production and physical imports alone. As different Member States have different renewable energy resources, costs will differ across Europe.

As discussed in Section 6.2, a cost effective exploitation of Europe's renewable energy resources occurs when national potential is developed on the basis of minimising costs. Targets set according to national potential therefore represent a cost effective development of renewable energy; targets set according to a flat rate/GDP weighting do not.

To assess the impact of trade on costs under a flat rate/GDP regime, a comparison can be made between the costs for Member States under "trade" and "no trade" scenarios. The results are presented in Table 36 Overall, the costs of not creating a transferable GO regime in the EU in 2020 could be up to €8 billion in 2020 or 0.06% GDP (assuming that Renewables targets are met exactly in each Member State).

Impact on reaching the targets

The "status quo" is a continuation of the existing regime. That is, whilst Member States would adjust their policies from the 2010 renewable energy targets to the 2020 targets, the overall regime would not change.

Currently, Member States have established policies and support regimes intended to reach their agreed 2010 targets for renewable electricity production and for biofuels production. In fact, recent Commission progress reports[61] highlight that 2010 renewable electricity production is likely to be 19% rather than the 21% target, and biofuels production 4.2% rather than the 5.75% target.

The progress reports explain that the failure to reach the targets is partly due to the uneven effort made across Member States, and that there is a need for additional incentives in a number of Member States. However the creation, extension or improvement of support schemes can be costly for Member States which makes achieving the targets more difficult. So whilst such improvements and expansions of best practice are necessary, the high level of ambition and the higher costs mean that there is a chance that Member States will not reach the targets without trade.

Impact on support schemes

Member States with green certificate regimes (Belgium, Italy, Poland, Romania, Sweden, UK) achieve their targets by placing an obligation on electricity suppliers to purchase X% green electricity, proven by ownership of green certificates, i.e. transferable GOs that verify the source of electricity.

The other main support scheme for renewable electricity is a feed in tariff regime (used in Austria, Cyprus, Czech Rep., Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Lithuania, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain). These are part of the physical electricity market: the tariff includes a premium on top of the electricity, paid with the purchase of electricity. Some of these Member States use a premium only system, whereby producers sell the electricity on the electricity market, but get a premium to compensate for the higher cost of renewable electricity.

Status quo means national support schemes would be untouched. Member States would be able to continue to introduce, adapt and reform their support schemes as they have been doing in recent years, as the chart below shows:

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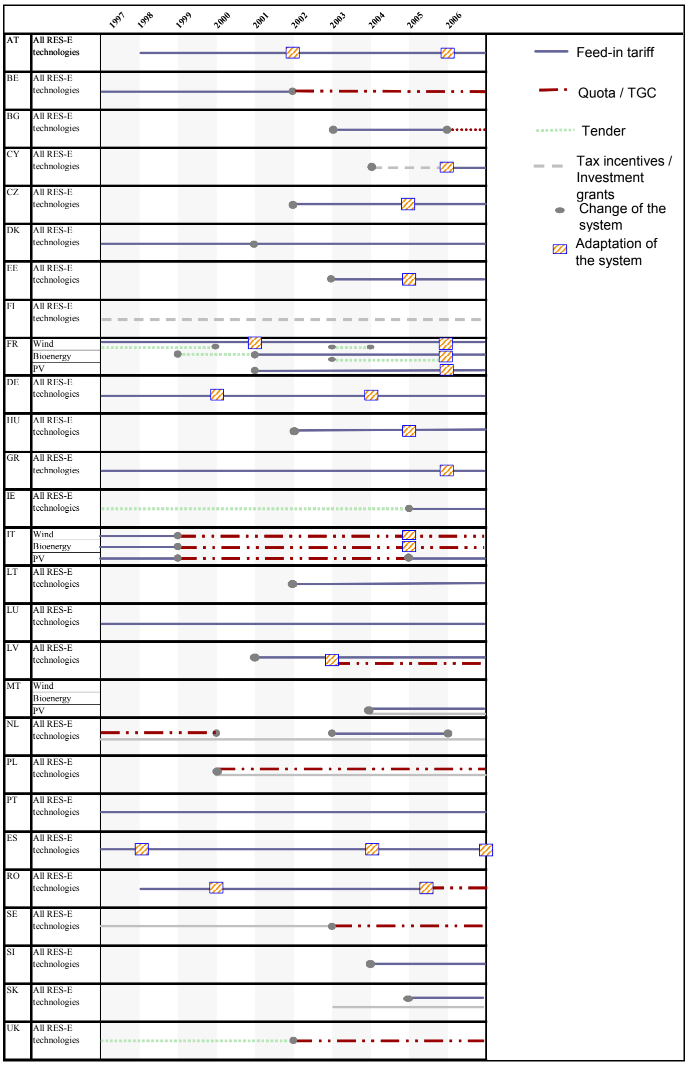
[61] COM(2006) 849 and COM(2006) 845.

Figure 9: Recent and current support schemes in Member States[62]



Source: OPTRES, 2007 (modified by DG TREN)

Impact on the internal market

Physical trade in energy will be one of the ways to reduce costs arising from the envisaged ambitious deployment of renewable energies. More physical trade could arise, including more players coming to the market, hastening competition in the electricity market and boost the Commission's initiatives to complete the creation of the internal market.

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[62] Quota obligations are usually coupled with tradable green certificate markets (TGC). For Netherlands, TGCs were introduced with a tax exemption. For Latvia, renewable obligation exists without the use of tradable green certificates. For Denmark, high and successful feed-in tariffs were abolished in 2000/2001 and premiums were introduced in 2003, after a transitional period. The framework for a tendering system for offshore was established in 1999. However, the political decision to implement was taken in 2004 and the tender was conducted in 2005. A change in the system represents a major policy change in the promotion of renewable electricity, i.e. change in support scheme. An adaptation of the system is represents modifications to existing support schemes, such as the introduction of tariff degression or technology specific tariffs.

At the same time, if national support schemes include sale obligations, such that renewable electricity must be sold to the national grid for a feed in tariff, then the electricity is prevented from entering the internal market. The lack of transferable GOs would not alter these arrangements, although such obligations are increasingly rare.

Impact on the functioning of the EU ETS

No GO transferability means that the cost of reaching the renewable energy targets is higher. Raising the marginal cost of renewable energy and the CO_2 abatement associated with the renewable energy. This means that as Member States develop renewable energy, they are undertaking carbon abatement measures that they would not otherwise take. This can then have an impact on non renewable energy CO_2 abatement: in particular, less abatement would be necessary from the non renewable energy sectors, which would result in a decline in carbon price. If Member States choose to meet their renewable targets domestically, they are limiting their flexibility to benefit from the EU ETS.

Impact on long term technological development

Not having any GO transferability or stronger relations between Member State means that Member States will need to continue to pursue their own technology priorities through their own national support schemes. Pursuing technology development only at the national level is more costly than development profiting from the more efficient exploitation of resources independent of the national location, and thus the costs of technology development would be higher.

Impact on energy mix.

The lack of GO transferability would mean that each Member State would exploit a different proportion or mix of its renewable energy resources (such as the exploitation of more expensive offshore wind or solar resources if cheaper onshore wind or biomass resources in another Member State were not available). PRIMES modelling suggests that this change in the mix of renewable energy exploited would have a limited impact on the overall EU energy mix.

In conclusion, maintaining the status quo of no transferable guarantees of origin would raise costs, and make it harder to achieve the targets. More physical trade could arise, more new players could come to the market and therefore increase competition in the internal market. It could reduce demand for emissions allowances and thus reduce carbon prices. Member states would be limiting their flexibility to benefit from the EU ETS; It could make technology development more expensive and slightly change the energy mix, resulting in higher emissions.

6.4.2. Option 2: an open market for guarantees of origin

As discussed in 6.3.4, GO transfers would allow targets to be reached with the lowest possible compliance costs. To understand the impacts of a transferable guarantee of origin regime, it is important to understand **how such a system could work**. With transferable GOs, energy companies or Member State governments would be able to meet their targets by buying guarantees of origin for renewable energy consumed in other countries.

First, a producer of renewable energy would request the issuance of a guarantee of origin for the renewable energy they produce. In essence, the producer then has two commodities: the energy and the guarantee of origin, which is valuable insofar as it can be exchanged for a subsidy in most Member States, either with the energy or on its own.

The producer could continue to sell its energy for a domestic feed in tariff or with a green certificate, depending on the domestic support regime available, or it could sell the energy domestically and sell the associated guarantee of origin to an energy supplier in another Member State, for a feed in premium or like a green certificate, to a foreign government or other interested party.

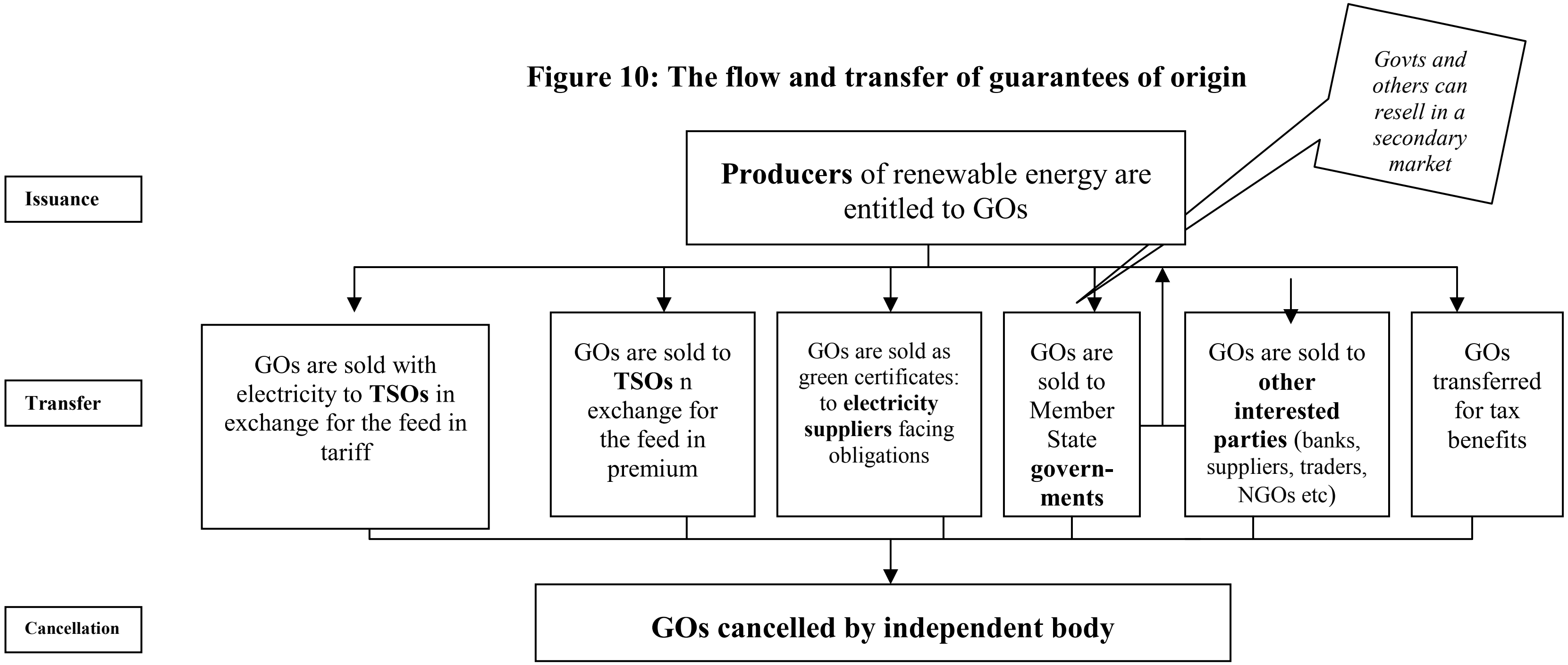
Conversely, a company facing a domestic obligation (e.g. the need to supply 10% of its electricity from renewable energy), instead of being obliged to buy domestic renewable electricity certified as such by a guarantee of origin, could instead by just the guarantee of origin from a renewable energy producer in another Member State. Similarly, a grid operator paying a feed in tariff could offer a feed in tariff premium for a guarantee of origin from a producer in another Member State. Or, a Member State government, instead of or in addition to creating a domestic support scheme or offering tenders to provide renewable electricity, could offer tenders to buy guarantees of origin from producers in another Member State.

When the guarantee of origin is exchanged for support or subsidy, such as a feed in tariff premium or green certificate price it would be redeemed and held by the Member State government. It would then count to that Member State's target, or it could be sold on to another Member State government.

The issuance and transfer of guarantees of origin would be managed by an independent body established in each Member State. This body would regularly determine the net balance of guarantees of origin and report to the Government.

These flows are depicted in **Figure 10**:

Figure 10: The flow and transfer of guarantees of origin



Impact on Costs

As discussed in section 6.4.1, transferability in guarantees of origin will allow for a more cost effective development of renewable energy resources across Europe. The estimates of cost given for the absence of guarantee of origin transferability in the status quo option constitute the cost savings under an open market option. Thus the cost savings of guarantee of origin transferability constitute up to €8bn.

For each Member State the savings can be considerable, and associated with such savings is an expenditure, if the Member State is importing GOs, or an income, if the Member State were to export GOs. An illustrative example is contained in the table below. PRIMES modelling suggests that revenues from selling GOs in some Member States could reach several billion Euros per year by 2020, and thus help considerably with encouraging and financing the development of renewables.

Impacts on grid planning and investment

Renewable energy production as represented by a GO, constitute a benefit insofar as they enable Member States to reach their targets. Renewable energy itself clearly has direct benefits, including:

- increased security of supply
- improved environmental and health conditions (less air pollution from conventional energy production)
- facilitating reaching climate target through reduced CO_2 emissions
- strengthening national innovation
- development of national industry
- increase of employment

At the same time, there may be local disadvantages from renewable energy deployment. One such possible negative effect being other environmental concerns than the climate issue, another one increased effort and cost for grid planning and development. For renewable energy sources, particularly so for intermittent energy sources (e.g. wind, solar), but also mainly due to that the location of the energy source can be different from where demand is, grid connection and development for renewable energy is often more expensive than for many conventional energy sources. In the case that renewable energy producers can export their GOs, it can be perceived that the benefits of renewable energy production are being exported, while the costs (through grid planning and development) have to be borne within the Member State. Therefore, if the GO is seen as the sole benefit of renewable energy production, there is clearly a disincentive for grid planning for excess capacity – a disincentive that in practice could mean a substantial risk to renewable energy deployment. Also, trading also means that there is less certainty of where future renewable energy will be developed (as it might as well be outside the Member State), so that planning becomes more difficult.

The Commission's view on the general market rules for the internal market in electricity are presented in the third energy liberalisation package. This states that a functioning market is a precondition to tackle climate change and ensuring that the renewables target is met. It does give suggestions as to how investment (including cross-border) grid should be made more efficient. But the fact remains that a substantial additional cost for grid development is needed to overachieve national targets and be able to export GO. This extra cost has, by each potential exporting Member State, to be balanced with the ancillary benefits listed above, to decide whether or not to develop an export industry of GO. This is not an easy calculation, and it is quite probable that in the case where the state budget is strictly limited (as will be the case for potential exporters where targets are GDP modulated), the potential long-term benefits of grid investments will not always be chosen. Therefore, as long as a Member State does not have control of cross-border trade of GO, there is an increased risk of grid development lagging behind, reducing the benefits of trade and increasing the cost of reaching the 20% target. On the other hand, grid development and access is already an issue under the present regime with no trading, and it is unclear whether trade of GO will make a marginal or substantial change to this issue.

Therefore, trading in GO can lead to increased risk for grid infrastructure planning and investment through providing a leakage of the benefits while keeping the costs within borders. On the other hand, there are several other ancillary effects that probably play in the other direction. The conclusion is that these issues are not substantial enough to prohibit trading, but that a cautionary approach should be used, such as Member States controlling level of GO exports, but with a defined minimum openness for exports.

Impact on reaching the targets

Section 6.4.1 noted that Member States have a range of support mechanisms in place already to achieve their 2010 targets and that the Commission's assessment is that such support is not sufficiently widespread or sufficient to in fact reach the targets. More effort is needed in more Member States. The reduction in costs that is possible resulting from the use of transferable guarantees of origin should mean that targets are easier to achieve and therefore likelier to be achieved.

At the same time, transferable GOs create a European system that would work in conjunction with national systems, and Member States' ability to develop and retain their own renewable energy would be constrained. If renewable energy producers are able to seek out the highest GO price irrespective of location, Member States would have to compete on price to attract a sufficient number of GOs to reach their targets (see discussion below for details).

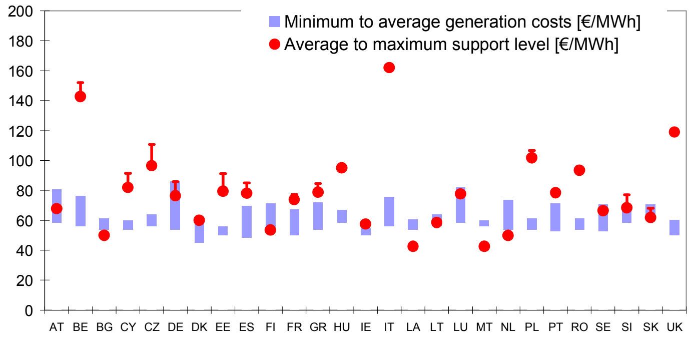
Finally, GO trade would put renewable energy targets at risk by raising uncertainty and risk to support schemes (discussed below). An industry whose growth is dependant on support (such as most of the renewable energy sector today) is sensitive to any change in support regimes and uncertainty can be translated immediately by finance markets into higher capital costs, countering the possible cost reductions from trade. In addition, 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.

Impact on support schemes:

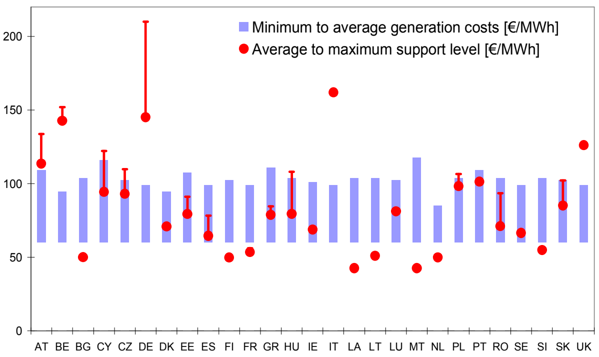
As noted above, the guarantee of origin as a commodity in essence gives a right to a support or subsidy regime. Insofar as transferable guarantees of origin constitute a market, the price of a guarantee will be determined by the subsidy available in any given Member State.

Current prices and quantities of GOs in green certificate regimes or of feed in tariffs or premiums schemes are known. The range of support in different Member States and for different electricity generation technologies is presented below:

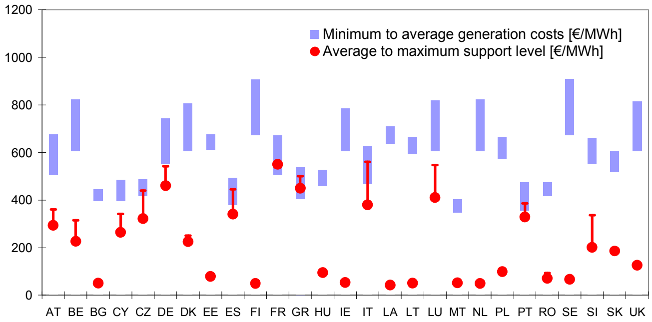
Onshore wind



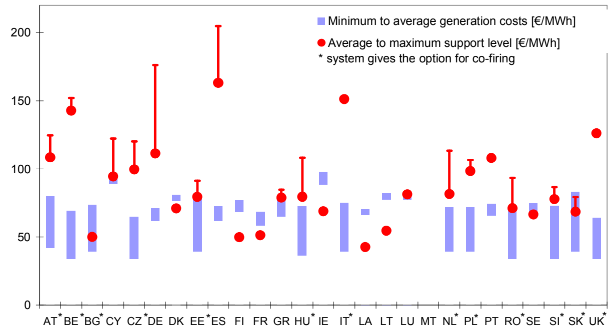
Biogas



Photovoltaic



Forestry biomass



Source: OPTRES, 2007

The graphs shows the current difference between power generation costs and revenues (support and price) in Member States. It can be seen that the difference between costs and prices in Member States with green certificates (Belgium, Italy, Poland, Romania, Sweden and the UK) is systematically greater than in the others, using feed-in tariffs. This is partly because green certificate systems require a higher risk premium to compensate for the price uncertainty resulting from market fluctuations. Feed-in tariffs, in contrast, are fixed for several years into the future. The risk premium constitutes a higher cost of support scheme, which has to finance a higher return on investments (or profit). Thus the high costs under green certificate regimes do not denote a high cost for renewable energy per se, but a transfer from consumers to producers for bearing market risk.

The above graphs also show that despite comparatively similar costs for the technologies across Member States (except for photovoltaics and biomass), support for renewable electricity production across the EU varies widely.

Price convergence

With a transferable GO regime, producers in a Member State with low green certificate prices or feed in tariffs or premiums would be inclined to try to sell their GOs in other national markets where green certificate prices, feed in tariffs or premiums were higher. Thus, as producers of renewable energy enter the market and get to choose where to get their subsidy from, the level of subsidies – the price received for the GO – should converge.

One aspect of the price convergence of GOs is the role of different renewable energy technologies. As is shown in the graphs above, some Member States today offer different levels of support for different technologies, chiefly through feed in tariffs, with the intention of reflecting costs: i.e. not paying the same high subsidies necessary for PV electricity production to wind-generated electricity, which is much cheaper to produce. If every Member State had the same technology banding, GO price convergence would occur, but with a different price for each technology. If one Member State does *not* distinguish between technologies, then a GO from any renewable energy technology could be sold there and a *single* GO price would emerge.

As a "GO price" emerges, it will be determined by the supply and demand for GOs, and thus be set by the marginal cost of the last unit supplied. Whereas national and technology specific schemes allowed a form of price discrimination with a large consumer surplus, a single European market allows the growth of the producer surplus and possible windfall profits. One external report of the results of such convergence suggests that windfall profits, or "producer rents" could reach €30bn by 2020[63].

In a static model, given the current situation of green certificate prices and feed in tariffs and premiums, such price converge would lead to rising feed in tariffs and falling green certificate prices. Whilst green certificate markets adapt automatically and would essentially become the same as the GO market, feed in tariff and premium regimes would need to be adjusted by governments on a regular basis to reflect changing GO market prices. These changes imply that green certificate regimes become less costly and that feed in tariffs become more costly. Similarly, the cost of support to consumers in each Member State would fall or rise, depending on the system in place.

In a more dynamic setting, the above short term variations to support scheme prices would change in light of the growing demand for GOs resulting from the new national targets.

The cost of uncertainty:

The risk-return relationship evident in green certificate regimes highlights how uncertainty in the sector has a direct cost. Uncertainty is a factor which can destabilise the market: renewable energy sectoral growth is driven by national subsidy regimes, dependant on the policy of the government. Establishing long term targets and price security through support schemes reduces uncertainty, making investment in new renewable energy production more likely and cheaper.

The evidence of the effect of uncertainty in *existing national* support schemes appears quite clear: green certificate regimes generally include a risk premium to compensate for price uncertainty; feed in tariffs provide price certainty. The result is that the riskier scheme requires a higher return. As the dynamics of the creation of a new, European market for

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[63] Working Paper S 8/2007 Ragwitz, Resch and Schleich, Fraunhofer Institute Systems and innovation research.

guarantees of origin, especially if specific safeguards are not included, are not totally clear, it is important to ensure that national targets and existing support structures are not undermined.

Thus regulatory risk arises from Member States' adaptation of their support schemes. This could be from *any* change to existing subsidy frameworks, such as the decline in the level of feed in tariffs and premiums, setting new limits on eligibility for support (for example a quota for feed in tariffs, new technology banding in green certificate regimes, stopping and starting support depending on current supply (in a capital intensive industry). Such regulatory risks occur in an industry that is completely dependent on the subsidy regime available. This means that regulatory risk translates immediately into a market risk. Changes to subsidy regimes directly affect the revenues of renewable energy producers and consequently their market risk profile, which in turn affects their cost of capital. Thus the uncertainty generated by opening up national support schemes could translate into higher costs for renewable energy producers.

Whilst these costs are to some extent ephemeral and should decline over time, they should not be ignored.

The broad macroeconomic impact of transferable GOs can be expected to include the generation of net savings in the achievement of the targets. However, transferable GOs can also be expected to have some impact on the green certificate market and on other support schemes. As described above, the transferability of GOs may lead to a need for adjustments to the way in which Member States choose to support renewables. This is the logical consequence of allowing greater flexibility in the fulfilment of targets.

Impact on the internal market

A transferable GO regime requires national support schemes to open up to non national GOs. This would result in price convergence, regulatory reforms and eventual harmonisation of support schemes. As such, production and other decisions of renewable energy producers that were influenced by national support schemes would be more related to economic factors. Transferability in GOs should be uncoupled from physical market to avoid any unwanted side-effects of GO transferability on energy market.

Impact on the functioning of the EU ETS

No impact on functioning of ETS. Transferable GOs do not include a CO_2 value. ETS remains the only way to trade CO_2. With transferable GOs the EU RES mix is likely to change slightly (41Mt CO_2 in 2020). Which implies slight downward pressure on carbon price.

Transferability of GOs will create a system where both reductions through the EU ETS as well as renewable development, and associated CO2 reductions, are not constrained by national targets

Impact on long term technological development.

The creation of a flexibility regime for GOs is intended to reduce or minimise the costs of reaching targets. As such, transferable GOs draw into the market the cheapest technology available and in a simple GO transfer regime no incentive would be provided for different technologies. In addition, when the technology neutral market clearing price for a GO is above the marginal cost of cheap renewable energy producers, the producers gain above normal profits. Thus, transferable GOs in GOs do not provide any dynamic efficiency (incentive for technology development) and ca lead to above normal profits.

Since MS can achieve target by supporting cheaper solutions in other MS, this could take focus away from national R&D developments. Again, general conclusion of learning curve logic remains that simultaneous rather than serial promotion of RES technologies is more cost effective in the long run. In addition, forced convergence of support scheme prices could also make it more difficult for individual MS to support specific technology in their MS.

The incentive to develop different technologies currently occurs through Member States' support schemes: feed in tariffs differ according to technology, providing an incentive for technology development and avoiding wind fall profits. Green certificate regimes can also be "banded" or technology specific obligations can be imposed on suppliers. Thus, if the GO transfers worked with existing support schemes, the dynamic efficiency of the support schemes could be maintained. If the transferability regime opens up the national support schemes, there is a risk that technology-specific incentives would disappear. As GOs would freely flow to the highest bidder, a full opening of a market for transferable GOs would have similar characteristics as a tradable green certificate market, with a lack of ability to promote the deployment of more expensive technologies. It is therefore desirable that specific forms of support for less mature technologies remain available alongside transferable GOs.

At the same time, it should be noted that some occasional adjustment of support schemes is normal in each Member State: tariffs are revised or other changes made to improve the system. Thus, the changing of support schemes is not of itself a negative and unusual event. The negative impact is the forced nature of such changes and the disruption to the market or other national priorities that result.

In conclusion, it is clear that there are major cost savings associated with the creation and use of transferable GOs. This is wholly consistent with economic theory. However, the flexibility provided by such a scheme would be accompanied by transfers of public support from renewable energy producers in one Member State to those in another. According to the simulation above, these transfers are large. However, the distributional transfers and uncertainty that is generated suggest a cautious approach to creating and opening the market is appropriate.

In the light of this, it is considered reasonable to conclude that the arguments point towards, rather than against, the introduction of a European system of transferable GOs. However, there are important arguments in both directions.

6.4.3. Option 3: a partially open market for guarantees of origin

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. One such approach is to leave the opening of the market up to the Member State: where Member States are clear that their targets or support schemes would not be undermined, they could allow GOs to be transferred into and out of the country. This has advantages. At a time of growing ambition to boost the growth in renewable energy, it would permit Member States to continue to manage their support schemes and renewable energy technology developments within their national territory. Thus "partial" market opening involves <u>creating the framework</u> for transferable GOs but <u>allowing Member States to determine</u> when it would be appropriate to take advantage of such a framework.

Member States could thus limit transferability by limiting the import and/or export of GOs, at least as long as they were on track to reach their target and make their contribution to the EU 20% goal.

Impact on Costs:

Greater cost effectiveness could be expected, compared to the no transferability case; less than in the full case. However, cost effectiveness would still depend on how well markets function, the degree of liquidity in the market for GOs and existence of barriers.

Limiting transferability in this way could substantially constrain the scope for achieving the potential cost savings available from efficient exploitation of resources across the EU. Transfers would only happen if governments in both the importing and the exporting Member State favoured it. So an importing Member State would be dependent on decisions of other Member States to open the market and renewable producers who would like to export would face unknown constraints on the value of their investments and the associated market value of the GOs; governments could constrain transfers desired by operators for budgetary, distributional or policy reasons, which may not be optimal from a European perspective.

If a Member State chooses to exclude imports from its support schemes, it will increase the cost of meeting its national target if national renewable energy resources are more expensive than the average. It would also reduce demand for GOs, which could have a negative affect on the price of GOs.

A Member State's limiting of exports would limit the supply of GOs available for transfer to other Member States, and thus the scope for reducing costs from transferability would be curtailed. Cost-effectiveness compared to full transferability would drop, as the supply of transferable GOs would decline and the price of GOs would therefore be likely to rise.

Impact on reaching the targets

If a Member State chooses to restrict imports, it will make the national target more difficult and expensive to meet. This applies in particular to countries that according to the methodology for target setting used have a target that is high in comparison to its cost-effective potential.

If a Member State restricts exports it maintains control of its domestic renewable energy production and thus of its ability to reach its target. However it would reduce other Member States' ability to import (by reducing supply) thus raising the cost and difficulty of reaching the targets for the other Member States.

Long term certainty - market and regulatory risk

Under a purely national system, renewable producers are subject to the national regulatory environment and its specific regulatory and market risks. These are related to the adequacy and design quality of the support system, the long term certainty that the support system provides the regulatory environment relating to licensing etc. As described under option 2, allowing imports could put domestic support systems under pressure, leading to change which can raise regulatory risk, thence costs and the possibility of not reaching the targets. So allowing Member States to limit transfers eliminates that additional regulatory risk.

At the same time, those renewable energy producers in Member States with volatile, inadequate or no support schemes would face an improved outlook if other Member States' support schemes became available; the "market" for subsidies opens up and the prospect of higher and more stable returns reduces their regulatory risk.

Impact on support schemes

A chief goal of a partial transferability regime is to create a GO system that *is* compatible with MS retaining their existing support schemes until they decide otherwise.

Member States' support schemes are used to help achieve non energy policies as well as energy policy. For instance encouraging energy generation from waste as part of a national waste strategy, or from forest products as part of a national forest management plan. Member States could thus limit GO transferability to avoid negative impacts on support schemes, to control the way in which they will meet their targets and to benefit economically from their own investments. For some Member States security of supply considerations also justify taking domestic measures rather than importing GOs.

A Member State importing GOs is foregoing a number of benefits relating to the national deployment of renewable energy, such as national CO2 emission reductions, security of supply and other sustainable development related (e.g. increased employment) benefits as these benefits will accrue to where production takes place. For this reason, Member States could possibly prefer to meet targets through domestic production, even though for some Member States this could come at a higher direct cost.

If a Member State *would* open up its technology differentiated feed-in tariff to foreign GO, it could attract such GO from across the EU. This is particularly true if a Member State has implemented attractive feed-in tariffs for currently more expensive but in the medium to long term promising technologies such as PV, tidal or offshore wind. It is important that such incentives remain in place from a perspective of technological and industrial policy of the country. If all GO from such a technology would be eligible to national support, it would possibly undermine the national support.

Impact on the internal market

Compatibility with internal market depends on each MS' support scheme and MS' desire to offer aid to producers in other Member States. Current trends in the reform of national support schemes suggest that Member States are increasingly aware of the need to improve the effectiveness of the schemes.

Reforms include the development of green certificate regimes, of feed in premiums, technology banding and stepped tariff reductions, all of which can help increase the role of the electricity market in giving price signals to the renewable energy sector and reducing possible distortions to the internal market.

At the same time, the creation of a market for GOs would be a new market in the EU. As a market, any restriction of the free movement of goods – in this case GOs – needs to be proportionate and justified.

Impact on the functioning of the EU ETS

no impact on the functioning of ETS, but a possible impact on carbon price.

Impact on long term technological development.

As MS, if in compliance, have choice to restrict or open for transferable GOs, impacts on long term technological development depends on their R&D policies and strategies

Impact on energy mix.

Emissions (reflecting RES impact on overall energy mix) are slightly lower than under a non transferable GO regime.

Conclusion

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.

Summary table

Criteria	**No transferability**	**Full transferability**	**Partial transferability**[64]
Cost-effectiveness	Cost effectiveness in EU would not be achieved since last MWh/Mtoe needed to achieve target in each MS has different marginal cost.	Greater cost effectiveness would be achieved with transferable GOs (However, this depends on well functioning markets and no barriers to development).	Greater cost effectiveness could be expected, compared to the no transferability case; less than in the full case. However, cost effectiveness would still depend on how well markets function and existence of barriers.
Ability to meet target	In principle yes. However, target will be achieved at higher overall cost for EU; higher costs put target at risk.	Yes	Yes
Compatibility with support schemes	Nearly all schemes are nationally orientated. This option would thus allow such schemes to continue uninterrupted, with MS undertaking reforms and improvements when appropriate.	Fully transferable GOs are not compatible with maintaining existing support schemes: transferability requires MS to open national support schemes to foreign production/consumption resulting in price convergence, with national support schemes needing to adjust tariffs, competing with others to attract GOs. First order expectations	A chief goal of a partial transferability regime is to create a GO system that *is* compatible with MS retaining their existing support schemes until they decide otherwise.

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[64] Option allowing Member States in compliance with interim target to restrict trade in GO for target compliance. Member States not in compliance with interim targets may not restrict GO imports for target compliance.

		would be a rise in feed in tariff/premiums and a decline in green certificate prices. This could constitute a major redistribution of support between Member States.	
Compatibility with internal market	Non transferable GOs raises costs and increases pressure for physical trade which would increase the number of players and competition in the internal market. Continued use of some support schemes raise internal market concerns. e.g. continued use of RES sale obligations (FITs) prevents RES-E entering the internal market (however such obligations are increasingly rare).		Compatibility with internal market depends on each MS' support scheme and MS' efforts to open up their support schemes to other MS or at least remove elements, such as sale obligations, which are not believed to be compatible.
Impacts on functioning of ETS	No impact on functioning of ETS. Non transferable GOs would result in less RES being produced in some MS (and more in others) than is cost effective, as MS aim for their targets. Where $MC_{ms}<MC_{eu}$ RES production would be lower than optimal, raising demand for other carbon abatement measures including ETS. And vice versa. Modelling suggests CO_2 emissions are 41Mt higher in 2020 than under a transferable GO regime, which would imply slight upward pressure on the carbon price.	No impact on functioning of ETS. Transferable GOs do not include a CO_2 value. ETS remains the only way to trade CO_2. With transferable GOs the EU RES mix is likely to change slightly (41Mt CO_2 in 2020). Which implies slight downward pressure on carbon price.	No impact on the *functioning* of ETS, but a possible impact on carbon price.
Impacts on long term technological development	MS would have to rely on own resources and technology priorities to reach targets. In addition, unable to profit from cheaper RES abroad, more would need to be invested in new, more expensive technologies. Higher expenditure/earlier production would bring down costs faster than would otherwise be the case.	Since MS can achieve target by supporting cheaper solutions in other MS, this could take focus away from national R&D developments. Again, general conclusion of learning curve logic remains that simultaneous rather than serial promotion of RES technologies is more cost effective in the long run. In addition, forced convergence of support scheme prices could also make it more difficult for individual MS to support specific technology in their MS.	As MS, if in compliance, have choice to restrict or open for transferable GOs impacts on long term technological development depends on their R&D policies and strategies.
Impact on energy mix	Emissions (reflecting RES impact on overall energy mix) are slightly higher under a non transferable GO regime.	Emissions (reflecting RES impact on overall energy mix) are slightly lower under a transferable GO regime.	Emissions (reflecting RES impact on overall energy mix) are slightly lower than under a non transferable GO regime.

Overview of the main policies for renewable electricity in EU

Country	Main electricity support schemes	Comments
Austria	Feed-in tariffs combined with regional investment incentives.	Until December 2004 feed-in tariffs were guaranteed for 13 years. From 2006 onwards full feed-in tariffs for new renewable electricity generation are available for 10 years, 75% and 50% available for year 11 and 12 respectively. The new feed-in tariffs are announced annually and support is granted on a first-come, first-serve basis. From May 2006 there has been a smaller government budget for renewable electricity support.
Belgium	Quota obligation system / TGC[65] combined with minimum prices for electricity from RES.	The Federal government has set minimum prices for electricity from RES. Flanders and Wallonia have introduced a quota obligation system (based on TGCs) with the obligation on electricity suppliers. In Brussels no support scheme has been implemented yet. Wind offshore is supported at federal level. The scheme is qualified as a public service obligation.
Bulgaria	Combination of feed-in tariffs, tax incentives and purchase obligation.	Relatively low levels of incentive make penetration of renewables especially difficult as the current commodity prices for electricity are still relatively low. A green certificate system to support renewable electricity developments has been proposed. Bulgaria recently agreed upon an indicative target for renewable electricity, which is expected to provide a good incentive for further promotion of renewable support schemes.
Cyprus	Feed-in tariffs (since 2006), supported by investment grant scheme for promotion of RES.	Enhanced Grant Scheme introduced in January 2006 to provide financial incentives for all renewable energy in the form of government grants worth 30-55% of investment. Feed-in tariffs with long-term contracts (15 years) also introduced in 2006.
Czech Republic	Feed-in tariffs (since 2002), supported by investment grants	Relatively high feed-in tariffs with 15-year guaranteed support. Producer can choose between a fixed feed-in tariff or a premium payment (green bonus). For biomass cogeneration, only green bonus applies. Feed-in tariff levels are announced annually.
Denmark	Premium feed-in tariffs (environmental adder).Tender schemes for wind offshore.	Duration of support varies from 10-20 years depending on the technology and scheme applied. The tariff level is generally rather low compared to the previously high feed-in tariffs. A net metering approach is taken for photovoltaics
Estonia	Feed-in tariff system	Feed-in tariffs paid for 7 -12 years but not beyond 2015. Single feed-in tariff level for all technologies. Relatively low feed-in tariffs make new renewable investments very difficult.
Finland	Energy tax exemption combined with investment incentives.	Tax refund and investment incentives of up to 40% for wind, and up to 30% for electricity generation from other RES.
France	Feed-in tariffs plus tenders for large projects.	For power plants < 12 MW feed-in tariffs are guaranteed for 15 years or 20 years (wind onshore, hydro and PV). From July 2005 feed-in tariff for wind is reserved for new installations within special wind energy development zones. For power plants > 12 MW (except wind) a tendering scheme is in place. The scheme is qualified as a public service obligation
Germany	Feed-in tariffs.	Feed-in tariffs are guaranteed for 20 years (Renewable Energy Act). Furthermore soft loans are available.
Greece	Feed-in tariffs combined with investment incentives.	Feed-in tariffs are guaranteed for 12 years with the possibility of extension up to 20 years. Investment incentives up to 40%.

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[65] TGC = tradable green certificates.

Hungary	Feed-in tariff (since January 2003, amended in 2005) combined with purchase obligation and grants	Fixed feed-in tariffs recently increased and differentiated by renewable electricity technology. No time limit for support defined by law, so in theory guaranteed for the lifetime of the installation. Plans to develop a TGC system.
Ireland	Feed-in tariff schemes introduced in October 2006, replacing a tendering scheme.	New premium feed-in tariffs for biomass, hydropower and wind introduced in October 2006. These tariffs are guaranteed for up to 15 years. Purchase price of electricity from the generator is negotiated between generators and suppliers. However, support may not be extended beyond 2024, so guaranteed premiums payments should start no later than 2009.
Italy	Quota obligation system / TGC. Feed-in tariff system for photovoltaic (introduced in August 2005).	Obligation (based on TGCs) on electricity producers and importers. Certificates are only issued for renewable electricity capacity during the first 12 years of operation, except biomass which receives certificates for 100% of electricity production for first 8 years of operation and 60% for next 4 years. Separate fixed feed-in tariff for PV, differentiated by size and building integrated. Guaranteed for 20 years. Increases annually in line with retail price index.
Latvia	Quota obligation system (since 2002) combined with feed-in tariffs.	Frequent policy changes and the short duration of guaranteed feed-in tariffs have resulted in high investment uncertainty. Main policy instrument reformed in 2007, maintaining the basic structure of the scheme. At national level there are yearly quotas and a mandatory purchase framework is set up for RES-E (combined with tendering for wind). Quantity of RES-E sold under the scheme is limited. Quota system (without TGC) typically defines small RES-E amounts to be installed. High feed-in tariff scheme for wind and small hydropower plants (less than 2 MW) was phased out in January 2003.
Lithuania	Feed-in tariffs combined with a purchase obligation	Relatively high fixed feed-in tariffs for hydro (<10 MW), wind, biomass, guaranteed for 10 years. Closure of the Ignalina nuclear plant which currently supplies majority of electricity in Lithuania will strongly affect electricity prices and thus the competitive position of renewables as well as renewable support. Investment programmes limited to companies registered in Lithuania.
Luxembourg	Feed-in tariffs.	Feed-in tariffs guaranteed for 10 years (for PV for 20 years). Investment incentives are also available. The scheme is qualified as a public service obligation
Malta	Low VAT rate and very low feed-in tariff for solar.	Very little attention to renewable electricity support so far. Very low feed-in tariff for PV is a transitional measure.
Netherlands	Premiums payments (abruptly abolished in August 2006).	Premiums guaranteed for 10 years were in place from July 2003. For each MWh renewable electricity generated, producers received a green certificate [GO] from the issuing body, which was redeemed for the premium payment. Government put all premium renewable electricity support at zero for new installations from August 2006 as it was believed that the renewable electricity target would be achieved in advance of 2010. Premium for biogas (<2MWe) immediately reinstated. The Netherlands aims to introduce a new support scheme as early as possible in 2008. The preferred support policy option is currently improved premium payments. Fiscal incentives for investments in RES are available [check].
Poland	Quota obligation system. TGCs introduced from end 2005 plus renewables are exempted from the (small) excise tax	Obligation on electricity suppliers with targets specified from 2005 to 2010. Penalties for non-compliance were defined in 2004, but were not sufficiently enforced until end of 2005. It has been indicated that from 2006 on the penalty will be enforced.

Portugal	Feed-in tariffs combined with investment incentives	Fixed feed-in tariffs guaranteed for 15 years. Level dependent on time of electricity generation (peak / off peak), renewable electricity technology, resource, and corrected monthly for inflation. Investment incentives up to 40%.
Romania	Quota obligation with TGC since May 2005.	A system of Green Certificates is in place, including a purchase obligation for distribution companies and the obligation to fulfil an annual quota of purchased green electricity. Quota obligation increase from 0.7% in 2005 to 8.3% in 2010. For the period 2005-2012, the annual maximum and minimum value for Green Certificates trading is 24 Euro/certificate, respective 42 Euro/certificate
Slovak Republic	Programme supporting RES and energy efficiency, including feed-in tariffs and tax incentives	Fixed feed-in tariff for renewable electricity was introduced in 2005. Prices are set so that a rate of return on the investment is 12 years when drawing a commercial loan. Low support, lack of funding and lack of longer-term certainty in the past have made investors very reluctant.
Slovenia	Feed-in system and premium, CO_2 taxation and public funds for environmental investments	Renewable electricity producers can choose between fixed feed-in tariff and premium feed in tariff. Tariff levels are defined annually by Slovenian Government (but have been unchanged since 2004). Tariff guaranteed for 5 years, and then reduced by 5%. After 10 years reduced by 10% (compared to original level). Relatively stable tariffs combined with long term guaranteed contracts makes system quite attractive to investors.
Spain	Feed-in tariffs and premium	Electricity producers can choose a fixed feed-in tariff or a premium on top of the conventional electricity price. No time limit, but fixed tariffs are reduced after either 15, 20 or 25 years depending on technology. Transparent system. Soft loans, tax incentives and regional investment incentives are available.
Sweden	Quota obligation system with TGC.	Obligation (based on TGCs) on electricity consumers. For wind energy, investment incentives and a small environmental bonus are available.
UK	Quota obligation system with TGC.	Obligation (based on TGCs) on electricity suppliers. Obligation target increases to 2015 and guaranteed to stay at least at that level until 2027. Electricity suppliers which do not comply with the obligation have to pay a buy-out penalty. Buy-out fund is recycled back to suppliers in proportion to the number of TGCs they hold. UK is currently considering introducing technology banding by differentiating certificates awarded to renewable electricity technologies. A tax exemption for electricity generated from RES is available (Levy Exemption Certificates which give exemption from the Climate Change Levy).

Source: OPTRES, 2007

6.5. Monitoring with national action plans

1. The option being assessed here is whether or not to require national action plans.

Extra administrative cost:

Most laws, both national and European, require monitoring to ensure that the measure has been correctly implemented and is being correctly applied. This is necessary for any effective monitoring and evaluation of a law. For European Directives in particular, it is common to require Member States to submit explanations to the Commission of how the Directive has been implemented and to provide reports to ensure that it is being correctly applied.

In the renewable energy sector, such reporting requirements are in place due to Directives 2001/77/EC and 2003/30/EC. Under a renewable energy Directive (that would replace the two sectoral Directives), these two reporting requirements would be replaced with one. In this sense, including the national action plans could constitute an administrative saving vis à vis the existing legal situation.

At the same time, consideration should also be given to whether such plans would be necessary even in the absence of the sectoral legislation. As a normal part of the implementation of European law, Member States must inform the Commission of the measures taken to apply the Directive. The proposal to do this in the form of a national action plan is intended to make the Member State's implementation of the law clearer to understand and simpler to monitor. So whilst it is more prescriptive than a general reporting requirement, its intension is to provide clear information for both Member States and the Commission as to the sound implementation and application of the law.

Assessing the additional costs is difficult as wages as well as efforts put into fulfilling this reporting requirement differ between Member States. An attempt to estimate the additional administrative cost is made using an average hourly rate across the EU of 65 € per hour for government officials and an average of 300 hours for completing the additional reporting requirement, taking into account that introducing a single reporting requirement instead of two. This would lead to an additional cost of € 19.500 per Member State. For the EU as a whole the additional cost would be a little over €0.5 mill. every second year, or € 263.250 per year.

2. The option of whether or not Member States should report on the availability and planned use of biomass resources for energy purposes.

It is clear that the achievement of the 20% target will require a significant increase in the use of biomass for energy purposes. The Renewable Energy Road Map projected that to reach the 20% share of renewables in energy consumption, use of biomass would be around 195 Mtoe in 2020. From this, around 30-35 Mtoe will be for biofuels (to achieve 10% minimum target).

Biomass is likely to make up around two-thirds of all renewables in 2020 (as it does today)

According to the evidence available to the Commission, the necessary biomass can be obtained under satisfactory conditions for the environment and for other users of biomass materials.

According to the European Environment Agency (EEA) report of 2006 on "How much bio-energy can Europe produce without harming the environment", significant amounts of biomass can be technically be available to support ambitious renewable energy targets (190 Mtoe in 2010 to around 295 Mtoe in 2030), even if strict environmental constraints are applied. The report also gives an environmentally-compatible bio-energy potential (in Mtoe) by Member State for 2010, 2020 and 2030.

It was for these reasons that the renewable energy roadmap concluded that the expected biomass contribution to the 20% target is achievable.

However, it is clear that care will need to be taken, and action will be required, to ensure that the resources that could be used are in fact made available for use.

Moreover, as biomass is used in all three sectors, electricity, heating and transport, the EU's Biomass Action Plan[66] argued there is a need for a coordinated approach on biomass policy.

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[66] COM(2005) 628.

Policies and support measures as well as technologies need to be in place to realise the potential and to ensure that biomass resources are used effectively and efficiently throughout the EU, so that supply can match the demand.

In order to ensure that biomass can contribute fully to achieving the targets, the EU Biomass Action Plan encouraged Member States to develop national Biomass Action Plans, to identify the EU-27's biomass potential (forestry, agricultural and waste) and opportunities for sustainable imports. The Commission sees such plans as having a key role in achieving the 20% target and ensuring the long-term and sustainable supply of biomass resources for energy use. Without such an approach, there is a risk of investor uncertainty in biomass and biomass technologies and potentially distorted competition in biomass trade. Therefore, to ensure the sound implementation of the Directive, national biomass action plans should form part of the National Action Plans to be submitted by Member States

> 3. In addition, the question of whether the sectoral targets are binding should and whether binding interim targets are necessary be assessed.

Effectiveness and subsidiarity

Subsidiarity issues were addressed fundamentally in the approach taken to the 2020 renewable energy targets: binding national targets would be set for renewable energy overall and sectoral targets would be left for Member States to set within their national action plans. That said, it should be recalled that national action plans are intended to provide a robust, verifiable monitoring instrument, and the reason for establishing sectoral targets is to provide industry with a degree of certainty about policy. On this basis, the effectiveness of both the national action plans and the sectoral targets depends on them being credible. Thus, requiring that sectoral targets are fixed and adhered to within the national plans is consistent with an effective monitoring regime.

The success of the policy and success in reaching the targets depends on the credibility of the targets. Thus adequate monitoring of the targets and the effective implementation of the directive requires the setting of interim targets. Interim targets for 2014, 2016 and 2018 constrain Member States' choice of "pathway" towards their 2020 target, but are necessary to ensure that action is taken in good time within the 13 year period and to guard against the possibility of slippage, which would render the targets void.

The setting of interim targets, based on a percentage of the growth needed to reach the 2020 target is required for the effectiveness of the directive, but could raise costs (unless the interim targets matched the least-cost development and deployment path for each Member State). At the same time, it is clear from analysis of renewable technology deployment that production costs decline with production growth. This learning curve effect means that costs come down over time (with production growth). Consequently, the deferral of deployment to a later time is not necessarily likely to be the least cost approach to reaching the target.

To mitigate against possible negative cost implications of setting interim targets, compliance periods (rather than specific point in time) will be used. As with the establishment of greenhouse gas national targets, the use of multi year compliance periods (through the use of an annual average target over the period) provides Member States with flexibility regarding how and when, within the period, they will reach their targets. In this way Member States retain a degree of control and flexibility over the manner in which the targets are reached.

6.6. Administrative, grid and market barriers

In the renewable energy sector, administrative procedures cover events ranging from power plant construction to household solar installations. Planning, licensing and permitting procedures, also in relation to grid connections, appear to be one of the clearest burdens for the industry in developing renewable energy, with small hydro power producers experiencing average planning permission periods ranging from one to twelve years[67] and onshore wind development from two to seven years[68]. Such delays disrupt supply, provoke uncertainty and can lead to higher risks that require higher returns in both debt and equity markets. Variations across Member States could also act as internal market distortions.

a) Do nothing more

A "do nothing more" policy at EU level would leave Member States free to take what actions they believe" necessary to reduce administrative barriers. However, reviews of administrative practices in Member States suggest that little unprompted action is taken and that the uneven pace and uneven efforts being made across the EU create even more barriers between Member States.

Such barriers and national differences can result in competitive disadvantages for businesses developing renewable energy technologies in what should be a single European market. For example, although Directive 2001/77/EC requested national actions to reduce administrative burdens, 52 different application procedures exist to get authorisation for a PV system in one Member State alone[69]. The progress report on electricity[70] also highlighted how administrative barriers are one of the reasons the EU is likely to fail to meet its green electricity target of 21% by 2010.

It is for reasons such as these that the EU created a target of reducing administrative burdens by 25% in five years and that action is necessary at the European level.

b) Strengthen requirements to simplify administrative procedures

As noted above, Directive 2001/77/EC said that Member States "should" take action to reduce and simplify administrative procedures, with very limited results. Thus, as a first approach to increasing national efforts in this area, it is suggested that Member States shall ensure that regulatory barriers are proportionate and necessary. Whilst this would constitute a strengthening of the law, it remains a very general requirement, providing no standards, minimum requirements or advice on best practice. It would provide the right framework for action but provides no specific guidance. As such, it is a necessary part of the legal framework for achieving the binding 20% renewable energy targets but more specific actions and requirements could be necessary to ensure concrete action is taken. Since no standards or minimum requirements are suggested, quantifying the impacts of this option is difficult. However, some analysis has been carried out to look at the impacts of reducing administrative burdens.

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[67] European Small Hydro Association, June 2007 "Administrative barriers for small hydropower development in Europe".

[68] European Wind Energy Association, July 2007 "main administrative Barriers for wind energy".

[69] European Photovoltaic Industry Association, June 2007 "Administrative barriers for PV Systems in EU Member States".

[70] COM(2006) 849.

Reductions in costs:

In broad terms, it has been estimated that the administrative burden on business in the EU is 3.6% of GDP and that a 25% reduction in administrative burdens in the EU would result in a 1% increase in real GDP (1.4% or € 150 billion in the long-run)[71]. In the electricity sector, the reduction of administrative burdens (in) have been estimated at €13 million with a multiplier effect of 0,7[72].

Employment impact:

Reducing or removing administrative barriers is likely to have positive and negative impacts on employment. With some administrative simplification certain jobs become superfluous; but the reduction in business compliance costs will generate economic growth that will boost employment. In general terms, Commission calculations using the QUEST model show that reducing administrative burden by 25% could increase overall employment, wages and GDP by 1.8%[73].

In the analysis below, a number of specific options for the reduction of administrative and market barriers are assessed. In each case it is assumed that the objective of simplifying administrative procedures is achieved without compromising EU and national legislation related to environmental protection.

c) Establishing a one-stop authorisation agency at national level

In all Member States, and particularly in Member States with a tradition of regional government, a range of different administrative authorities can be responsible for different parts of the planning process. Commission analysis has noted that this causes confusion and delays for business planning and that a "one-stop-shop" to simplify the process is recommended[74].

In one illustrative case study of the costs of such measures, recent Italian efforts taken to create a "one-stop-shop" in pollution control (IPPC) procedures reduced the number of steps in the procedure from 11 to five, reduced average completion time from 16 weeks to one week, and charges fell from €1,150 to €340. In a different Dutch case, aggregate net savings for business were estimated at €329 million[75].

Given the concerns regarding complex administrative burdens in the renewable energy sector, it is likely that net benefits would also be generated. However, as structures and

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[71] Tang and Verveij, 2004 "The cost of non Lisbon, Issue Paper", extrapolating from Dutch data. The administrative burden has been estimated by the OECD to be between 3 and 5% of EU GDP. Gelauff, G.M.M. and A.M. Lejour (2006). "Five Lisbon highlights: The economic impact of reaching these targets". CPS Document 104, The Hague, prepared for DG TREN. Commission Staff Working Document "Action Programme for Reducing Administrative Burdens in the European Union – Impact Assessment" - SEC(2007) 85.

[72] Danish Ministry of Economic and Business Affairs, "Growth Report, 2005": Chapter 6 Growth and administrative reductions).

[73] The Commission Staff Working Document SEC(2007) 84 on Action Programme for Reducing Administrative Burdens in the European Union – Impact Assessment.

[74] OPTRES, Assessment and optimisation of renewable energy support schemes in the European electricity market, Ragwitz et al. fraunhofer ISI et al.

[75] European Commission Memo 06/244 of 22 June 2006.

responsibilities differ between Member States and as administrative arrangements themselves are normally a matter of subsidiarity, it is proposed that this type of measure remain a recommendation rather than a requirement.

d) Guidelines with clear attribution of responsibilities between national, regional and local authorities for authorisation procedures, clear deadlines for approving planning and building applications and clear guidelines for coordination between administrative bodies, concerning time limits and receipt and handling of planning and permit applications.

As with c) above, clarity regarding the different levels and areas of responsibility for authorisation of planning or equipment installation and instituting clear deadlines would benefit all actors involved: businesses planning new projects, households, and public administrations themselves. Quantifying the impacts on for example cost (reductions) for governments and businesses, employment and penetration of renewable energy are difficult to determine as different methods for fulfilling this obligation could be implemented in different Member States. It could be assumed that Member States would not implement measures to fulfil this obligation unless they lead to an overall net benefit.

e) Automatic approval of planning and permit applications where authorisation body has not responded within the set time limits

This option would discipline authorities to handle applications within deadlines. However, as structures and responsibilities differ between Member States and as administrative arrangements themselves are normally a matter of subsidiarity, it is proposed that this type of measure remain a recommendation rather than a requirement.

f) Establishing lighter authorisation procedures for smaller projects

A "fast track" procedure specifically adapted for smaller projects, in which a smaller number of permitting authorities and possibly also shortened consultation and permitting times are instituted, could have positive impacts on the development of renewable energy projects in situations where detailed investigations of each case are disproportionate.

g) Establishing spatial planning mechanisms whereby regions and municipalities assign locations for different renewable energies.

A further element of uncertainty and market information failure is knowledge of the feasibility of different types of renewable energy technology in different locations. Effective spatial planning regimes could reduce conflicts and difficulties concerning permission procedures for renewable energy projects, reduce the required time period for approval and provide useful information to all parties concerned. As for option c) and e) spatial planning is normally a matter of subsidiarity, and it is proposed that this type of measure remain a recommendation rather than a requirement.

Some additional costs for public administration would be associated with spatial planning, as local authorities would need to invest the resources to define dedicated development zones. The costs associated with creating the renewable energy development zones would depend on the extent to which the feasibility maps would be part of general land use planning activities. Several global maps have already been created by researchers/national laboratories for wind, solar or geothermal sources and these could be utilised together with land-use planning instruments to create potential renewable energy zones. Moreover, official feasibility maps would also help companies/ individuals find financing for renewable energy.

h) Requiring Member States to review the framework or rules for bearing and sharing of grid investment costs that are necessary to integrate new renewable electricity producers into the interconnected grid with the aim of improving it

In the existing Directive 2001/77/EC Member States are already required to establish a framework or rules for bearing and sharing of grid investment costs, the additional requirement under this option is to review the framework with the aim of improving it. The costs of connecting renewable energy to the grid are usually very high and can in some cases lead to projects not being developed. In addition, more transparent and non-discriminatory rules, where project developers can verify technical and cost data presented by the operator are recommended. A review is also needed to reflect on the impact of the growing share of renewable energy. The Renewable Energy Roadmap impact assessment noted that the share of renewable electricity could grow to 34% by 2020 and variable renewable electricity (wind, solar, wave and tidal) to 15% without affecting grid stability. It highlighted that the regulatory framework, including forecasting, gate closure and balancing cost regimes, will need to be examined in light of such growth. A review of the cost sharing and bearing framework is sure to generate additional costs for public authorities or transmission or distribution operators. However, these costs could be outweighed by the benefits of increased penetration of renewables, resulting from an improved framework for connecting renewable energy to the grid and also from improved market efficiency that could result from a better framework.

i) Mutual recognition of certification

Whilst CEN or ISO standards exist for most renewable energy equipment, additional national certification schemes are often imposed by Member States to enable the product to qualify for a grant or other type of support, or to meet insurance requirements and so on. These extra certification procedures can involve applications for further product tests and extra time and costs. Thus, additional national certification regimes act as a barrier to trade and to the growth of the sector.

As an illustrative case of the costs of such measures, the "Solar Keymark" is a useful example. Solar thermal products which comply with CEN standards qualify for the Solar Keymark certificate, recognised in most Member States. However, some Member States have additional national certification requirements which do not automatically recognise the Solar Keymark and therefore create an additional burden for companies to access a market[76]. Qualification by the national Centre Scientifique et Technique du Bâtiment, for example, can amount to €15.000[77]. Therefore appropriate mutual recognition of certification based on European standards would be an important cost-reducing measure and would also remove administrative burden.

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[76] MVV Consulting, 2007 "Technical Assistance on the standards and codes applied to heating and cooling from the renewable energy sector http://ec.europa.eu/energy/res/sectors/heat_from_res_en.htm.

[77] MVV, 2007. In order to get a CSTBat certification for an already keymark tested solar collector, some of the tests already required for the Solar Keymark are accepted by CSTB. Hence, in this case the additional costs will be less than the above mentioned cost figures. An estimation of the additional costs resulting from the required certification of system is quite difficult, since the testing effort depends on the number of systems being part of a family. However, as an indication an amount per system test of 10 000 EURO seems to be realistic.

To avoid barriers to trade and to lower administrative costs, mutual recognition of certification regimes could be appropriate.

j) Instituting precise deadlines for planning and building application approval

Licensing procedures for renewable energy (electricity) projects usually require a variety of different permits, such as pre-siting permission, installation, building, operation and generation licenses as well as approval of environmental terms and conditions. These procedures involve a multitude of central, regional and local authorities. Clear guidelines as to who is responsible for what can have a positive impact on the often unnecessary interwoven and lengthy procedures. A "clean up" of procedure responsibilities and better coordination may result in some jobs becoming redundant, but one could expect that these impacts would be outweighed by the positive impacts resulting from of quicker and less costly procedures for renewable energy projects.

As existing planning regimes in Member States have no fixed deadlines, and can sometimes take several years, the specification of deadlines would provide certainty in the planning process, which can reduce the costs of developing renewable energy projects and construction costs.

Such clarity would improve the planning accuracy of developers which in turn can have a positive effect on support schemes, as delays in planning approval have caused support scheme budget "stop-and-go" problems. This occurs when support scheme budgets are fully allocated but planning approval delays result in construction delays and a failure to draw on the support within the budget year[78].

The creation of a clear planning approval calendar or timeline should improve the efficiency of the processing of applications, without creating an extra administrative burden. More clarity should facilitate applications and the growth of the use of renewable energy. In fact shorter deadlines can be achieved by reducing the number of administrative procedures, as in the case of Germany, where no building permission is required to install PV on private houses, except on historical buildings. The requirement of precise deadlines should not impose extra burden or cost on authorities, yet should provide more certainty to project planners and encourage the development of renewable energy projects.

k) Requiring renewable energy use in new or renovated buildings

To achieve an increased uptake of renewables in buildings, one option is to oblige Member States to require a minimum proportion of renewable energy in the energy supply of new buildings or buildings undergoing major renovation, with appropriate exemptions, such as where low-energy and zero energy buildings are planned or where there is a local lack of renewable energy sources.

Installing energy equipment in new or renovated buildings is generally cheaper than when installing equipment in existing buildings. This is because more efficient systems approaches are possible, or sometimes simply because access is easier so installation costs are lower. In addition, it is possible that price elasticities of demand are lower, as equipment purchases are assessed in the context of much higher building, reconstruction or renovation costs.

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[78] Heating and cooling from renewable energies: costs of national policies and administrative barriers, MVV Consulting, Contract MVV Consulting /, DG TREN 28/06/2006No TREN/CC/05-2005 Lot 3 : Technical Assistance activities.

As both actual and possibly perceived costs of equipment and installation are lower when renovating or erecting a new building, it is an appropriate moment to install renewable energy equipment rather than conventional energy equipment. This has already been recognised in EU law, in Directive 2001/91/EC, which requires consideration of the feasibility of renewable energy sources before the construction or refurbishment of buildings (over $1000m^2$). However, as in option b) above, the "consideration" of such issues is voluntary, difficult to monitor, and not always effective.

At the same time, the practice amongst certain Member States is increasingly to impose stronger renewable energy requirements in buildings regulations. National measures, based on the so-called "Barcelona model"[79], increasingly require a minimum amount of energy to be generated from renewable sources in new and refurbished buildings of all sizes. The evaluation of the Barcelona model suggests that such a measure is effective, has a minimal cost and is increasingly popular. The ratio of renewable energy-supplied buildings to population rose from $1.1m^2/1000$ to $20.7m^2/1000$. This growth in the use of renewable energy was estimated at 24,840 MWh/year (an increase of 1782% over 6 years), resulting in CO_2 savings of 4,368 tonnes of CO_2 equivalent, and generating economic savings of €1,376,150. Initial problems of monitoring and communications were overcome and in fact the law became a stimulus for architects and engineers to find out about methods of calculation, materials and equipment.

Following a 2006 review of the scheme it was extended (a 2010 target of 778 GWh/year was set) removing the minimum building size threshold, raising the swimming pool heating requirement to 60% and varying the building heating requirement according to hot water demand[80]. The law has been adopted by 65 other Spanish municipalities, 12 Italian municipalities, in the German town of Vellmar, in Wallonia and in Merton Borough (UK). In March 2006 the scheme was incorporated (in a modified form) into the national Spanish technical building code and in April 2006 a similar approach was adopted in Portugal. Currently Rome and Baden-Württemberg are considering such laws, as is Italy at a national level[81].

The modification of planning rules to require minimum levels of renewable energy thus appears to be an effective and increasingly popular means of increasing the growth of renewable energy, particularly in heating systems. It is a policy measure that avoids budgetary implications and appears to stimulate information dissemination and learning by professionals, thus over coming a range of the barriers identified to the growth of renewable energy particularly for heating and cooling.

Whilst in Mediterranean countries the focus on solar thermal energy and requirements of high levels of renewable energy use is reasonable, no such requirement could be imposed at the European level. The use of different sources of renewable energy varies widely within and certainly between Member States, thus an overly prescriptive requirement based on certain technologies and proportions is inappropriate. It is, however, clear that all Member States

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[79] The Barcelona law first entered into force in 1999, requiring between 60% and 70% of hot water to be sourced from solar thermal sources in new or renovated buildings with hot water demand of more than 2000litres/day and a minimum of 30% for heating swimming pools with a capacity of more than 100m3. Exemptions were permitted on certain defined practical and aesthetic grounds. By the end of 2005, 25% of new buildings (corresponding to 428 buildings or 31,050m2) had to comply with the law.

[80] "The Barcelona Solar Thermal Ordinance", Barcelona Energy Agency , www.barcelonaenergia.com .

[81] See K4RES project data, http://www.erec-renewables.org/64.0.html.

have considerable scope for increasing the level of use of renewable energy (in whatever form). Thus a requirement that national planning rules require *some* level of use of renewable energy, to be determined at national, regional or local level as appropriate, provides a sufficient degree of flexibility, whilst ensuring that best practice in the extension of a clearly low cost and effective measure promoting renewable energy is spread across all Member States.

l) Providing objective information and training

This option requires Member States to provide accurate information and training on the availability of different types of equipment, their benefits and the means and processes of installing them. Such information is important for consumers wishing to make informed decisions, and to ensure a high quality service offered by architects, equipment suppliers, planners and builders.

The lack of information and training of renewable energy professionals are considered important reasons for lack of growth in renewable energy technologies in the heating and cooling sector. Certain renewable energy technologies for heating and cooling, notably solar thermal energy and heat pumps, were developed in several Member States in the 1970s and 1980s. Despite initial high growth rates, the market declined in the late 1980s. Several studies, including the Intelligent Energy Europe project EARTH[82], argue that this decline was due to the poor quality of initial installation and the absence of any follow up maintenance contracts or guarantees. The EARTH report recommended Europe-wide accreditation schemes installer training and certification with a strong common EU compatible dimension.

Other EU law already addresses professional training and mutual recognition of professional qualifications. However, to ensure compatibility between schemes, accreditation should be based on common or minimum requirements of training/ professional experience, which also take account of European standards for renewable energy systems and installations, such as heat pumps and biomass boilers as well as solar panels.

There are costs associated with information and training campaigns, but according to an IEA study[83], information provision and knowledge based promotion are needed in conjunction with other political tools and a lack of information may inhibit investment in renewable energies[84]. Moreover, additional training costs can be minimised as they are supplementary to existing training programmes already present in most Member States.

Although the scope of training schemes for renewable energy professionals should be left to Member States to develop, compatible and mutually recognisable accreditation may help installers to be recognised as such in all Member States, without the need to undergo 27 different certification procedures. This may be effectively done through ensuring that accreditation is based on common criteria for training and EU standards. The European standardisation bodies must therefore continue their work to develop standards for renewable energy technology, including biomass stoves and boilers.

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[82] EARTH (Extend Accredited Renewables Training for Heating) http://www.earth-net.info/ The project carried out nine Member State surveys and found that is the only Member State with a certification schemes for installers.

[83] IEA, September 2007 "Renewable Energy Heating and Cooling: Technologies, Markets and Policies".

[84] As an example, spent € 2.6 million over 4 years on information and promotional events, training measures for installers, planners, information websites, brochures etc. to support solar thermal energy. Over six years, total installed solar thermal collector area in increased by almost 80%.

Conclusion

Analysis of each sector of the renewable energy industry, together with assessments made by the Commission when reviewing progress under Directive 2001/77/EC highlight the role administrative, grid and market barriers have in stunting the growth of renewable energy.

Whilst current EU laws contain provisions extolling administrative reform and simplification, little progress has been made and various administrative procedures remain a key barrier to growth. Thus, a strengthening of the general requirements to undertake administrative reforms and simplification is appropriate. For several of the detailed administrative reforms assessed, such as establishing a one-stop authorisation agency, automatic approval of planning and permit applications when authorisation bodies have not responded within the set time limits, and establishing spatial planning mechanisms subsidiarity rules imply that such detailed organisational matters should be left to Member States. Since the decision as to whether or not to implement these measures and how they should be implemented is left the Member States, it is more appropriate that impact assessments are carried out at Member State level. For other options however, a consistency of practice across Member States is necessary to avoid unfair competition and distortions to the single market. It is therefore recommended that the draft Directive proposal includes requirements on Member States to introduce measures to reduce market barriers (mutual recognition of certification, requiring renewable energy use in new buildings and providing objective information and training).

The new measures identified will require an extra administrative effort on the part of public authorities. The administrative costs of providing accurate information and training on the availability of different types of equipment will heavily depend on what information and training is already available in Member States today, and what efforts Member States are willing to put in place to improve existing activities. It is difficult to estimate the administrative cost of reviewing the grid investment costs rules. An attempt to estimate the additional administrative cost is made using an average hourly rate across the EU of 65 € per hour for government officials and an average of 200 hours for a yearly review. This would lead to an additional administrative cost of around € 350.000 for the Member States in total.

In addition, removing administrative barriers by reducing the number of permitting procedures or creating one-stop-shops may lead to some public authority jobs becoming superfluous. However, less time and money spent on administrative procedures for businesses is likely to increase profits and therefore employment in the renewable energy sector.

More importantly, these measures would contribute to the EU's sustainable energy policy and would not compromise EU and national legislation related to environmental protection. A win-win situation could therefore be achieved if efforts to reduce lengthy and costly procedures result in more deployment of renewable energy with the same level of environmental protection.

With this in mind, the local impacts of each option are summarized below.

Table 31: Impacts administrative and market barriers of different options

	Cost effectiveness	Increase in RES	Internal Market	Competitiveness	Additional costs
Do nothing more	Low	Low	n.a.	low	low
Strengthening requirements to simplify administrative	High	Medium	Medium	medium	low

procedures					
Establishing a one-shop authorisation agency at national level	High	High	Low	High	Medium
Clear guidelines with clear attribution of responsibilities between authorities	Medium	Medium	Medium	Medium	Low
Establishing lighter authorisation procedures for smaller projects	Medium	Medium	Low	High	Low
Establishing spatial planning mechanisms, with assignment of locations for different renewable energies	Low	Medium	Low	Medium	Medium
Mutual recognition of standards and certificates	High	Medium	High	High	Low
Instituting precise deadlines for planning approval	High	Medium	Low	High	Low
Requiring renewable energy use in new building projects	High	High	Medium	Low	Medium
Providing objective information and training	Medium	Medium	Medium	Medium	Medium
Requiring review of framework for bearing and sharing of grid investment costs	Medium	Medium	Medium	Medium	Medium

It is recommended to reject the option of doing nothing more and to proceed with all the other measures listed in the table, either as a recommendation or where needed in order to ensure consistency across Member States and/or to avoid market distortions and unfair competition, as a legal requirement.

6.7. Achieving a 10% share of biofuels

In the renewable energy roadmap, the Commission assessed the impact of the achievement of a 10% share of biofuels in transport in 2020. It concluded that this would mean extra costs averaging €5.3 bn per year, reduced oil imports from the Middle East and Confederation of Independent States rising to 31 Mtoe per year in 2020, extra employment in the EU rising to 120 000 per year in 2020[85] andgreenhouse gas emission reductions rising to 68 $MtCO_{2eq}$ in 2020[86].

The impact assessment drew on a more detailed exploration of the economic and environmental effects of biofuel use[87]. In relation to a biofuel market share of 14%, this drew the following additional conclusions:

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[85] Employment is expected to be created in the agricultural, food and biofuel sectors while there are expected to be some offsetting losses in the services, fuels, transport and energy sectors.

[86] Renewable energy roadmap, impact assessment, p. 28.

[87] Biofuels progress report - COM(2006) 845; review of economic and environmental data for biofuels progress report - SEC(2006) 1721.

- Biofuels contribute to short-term security of energy supply by reducing the need to keep oil stocks to protect against disruptions. The value of this can be estimated at about €1 bn per year.

- The best way to promote long-term security of supply is to diversify energy sources. In transport, energy diversity is rather low. Biofuels add to energy diversity by increasing the diversity of fuel types and of regions of origin of fuels. It is not obvious how to place a monetary value on this benefit.

- European demand for biofuel imports can contribute to improving trade relations with the EU's trading partners, and provide new opportunities for developing countries which have the potential to produce and export biofuels at competitive prices.

- If the growing of feedstock for biofuels takes place on land that is appropriate for the purpose, the environmental impact (setting aside the greenhouse gas benefits) will be manageable. If increased biofuel use leads to feedstock being grown on land that is inappropriate – such as natural forest and other habitats of high nature value – it will cause substantial environmental damage. There is no need to use this land to achieve a 14% biofuel share.

- With a 14% biofuel share, the price of agricultural commodities would be expected to be slightly higher than today. The rise in prices of agricultural products should benefit farmers and rural communities, notably in developing countries. It could be detrimental to poorer populations. However, it should be underlined that 70% of the world's poor are also rural, and hence can also be among the beneficiary group of rising agricultural prices.

- Second-generation biofuels are not yet commercially available. They are likely to be more expensive than first-generation. In 2020, both first-generation and second-generation biofuels can be expected to be in the market. The development of second-generation biofuels would help boost innovation and maintain Europe's competitive position in the renewable energy sector, as well as offering improved greenhouse gas savings.

Based on this assessment, the Commission declared its intention of including in its legislative proposal a provision for a binding 10% target for the share of biofuels and other renewable fuels in petrol and diesel use in transport in each Member State. This approach was endorsed in the conclusions of the spring European Council and in the European Parliament's vote on the Thomsen report. It is not the function of the present impact assessment to repeat the investigation of whether such a binding target is appropriate, nor to repeat an analysis of its impact.

The 10% biofuel target needs to be seen in the wider framework of targets for renewable energy and for greenhouse gas emissions. The proposal for overall targets for renewable energy was already taken into account in the analysis summarised above. Biofuel use will contribute to Member States' achievement of their targets for greenhouse gas emissions in the non-ETS sectors. The adoption of this wider framework does not alter the analysis above.

Recent increases in the price of agricultural commodities are attributable only to a small degree to EU biofuel policy[88]. They will make biofuel production more expensive than was

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[88] See section 6.5.7.1.1 (iv).

expected at the time of the analysis summarised above. However, recent increases in the price of oil will reduce the excess cost of biofuels relative to conventional fuels; and this effect outweighs that of the increase in price of agricultural commodities. Thus, the cost-effectiveness of the policy is higher under present conditions than at the time it was first proposed.

The issue to be addressed here is how to design a legislative proposal that will ensure that the 10% target is achieved in an optimal way (without prejudging action in other policy areas that is also important for that objective).

In the renewable energy roadmap, the Commission identified three factors that need to be taken into account in the design of an optimal legislative framework for the promotion of biofuels: criteria for the *sustainability* of biofuels, tools to promote the development of *second-generation biofuels* and other especially desirable biofuels, and ensuring that *fuel standards* are compatible with the efficient achievement of the 10% target.

The conclusions of the spring European Council also identified the need to pay attention to these three factors[89], as did the European Parliament's vote on the Thomsen report. The remainder of this section of the impact assessment therefore addresses the key issues in the design of the legislative framework for biofuels, focussing on the three factors identified above.

This section of the impact assessment examines the options for sustainability criteria (greenhouse gas emissions, biodiversity, other environmental aspects, food security and social impacts) in light of their feasibility, WTO compatibility and significance. It analyses the options for measuring and the minimum standards that could be applied for GHG emissions, biodiversity and other environmental aspects. It goes on to explore the possible penalties for failing to meet the criteria, the means of verification and the methods of reporting compliance. The overall impact of the proposed sustainability scheme is given in section 6.7.1.6.

Next, the options for promoting second generation biofuels are explored. Finally, the means of ensuring that fuel standards allow the achievement of the 10% target are examined.

This impact assessment explores the following main effects of biofuel promotion:

- greenhouse gas impacts
- biodiversity impacts
- other environmental impacts
- food security impacts
- social impacts

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[89] The Council endorsed a 10 % binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption by 2020, to be introduced in a cost-efficient way. The binding character of this target is appropriate 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. The Commission made a statement to the minutes of the Council stating that it did not consider that the binding nature of the target should be deferred until second-generation biofuels became commercially available.

- security of supply impacts
- additional impacts from indirect land use change.

6.7.1. Options for ensuring the sustainability of biofuels

In order to design an efficient and effective set of biofuel sustainability criteria, the following questions need to be addressed:

i) What aspects of the impact of producing biofuels should the criteria cover?

ii) How should the impact of producing biofuels be measured?

iii) What should be the required minimum level of performance?

iv) What should be the consequences of failing to meet the required minimum level of performance?

v) How should performance be verified?

This section assesses responses to these questions. It concludes by describing the recommended scheme and estimating its overall impact.

6.7.1.1. What aspects of the impact of producing biofuels should the criteria cover?

(i) Introduction

The options assessed are greenhouse gas impacts, biodiversity impacts and other environmental impacts, food security impacts and social impacts. Economic impacts are not assessed.

In deciding whether or not to include a particular type of impact, the following criteria are used:

- Feasibility of associating impacts with individual consignments of biofuel
- International law aspects
- Possibility of biofuel production having a negative impact

(ii) Feasibility of associating impacts with individual consignments of biofuel

The purpose of introducing sustainability criteria for biofuels is to enable a distinction to be made between fuel that meets the criteria and fuel that does not.

In order for a particular impact of biofuel production to be taken into account for this purpose, it must be possible to link the occurrence of the impact to an individual consignment of biofuel.

Positive greenhouse gas impacts derive from the quantities of fossil fuel that an individual consignment of biofuel replaces. Negative greenhouse gas impacts derive from the processes used to produce individual consignments of biofuel. Biodiversity and other environmental impacts derive from factors such as the nature of the individual plot of land used to cultivate the raw material for the biofuel. It is feasible, therefore, to associate these impacts with individual consignments of biofuel.

Social impacts derive from factors such as the quality and quantity of employment, respect for fundamental human rights or land rights associated with all agricultural production including the production of consignments of biofuel. Associating such social impacts with individual consignments of biofuel is much less straightforward than greenhouse gas impacts or the use of the individual plot of land. Such impacts may derive from other issues, such as lack of relevant legislation, or from lack of enforcement of otherwise satisfactory norms. Addressing these issues in relation to individual consignments of biofuels raises technical and administrative issues.

It is not possible to associate food security impacts with individual consignments of biofuel. This is because changes in agricultural commodity prices, caused by changes in demand and supply, are the main way in which biofuel policy will affect food security. In general, these prices are set in global markets. This means that food security impacts are likely to be difficult to be attributed to the precise location of the production of biofuels and their feedstock. For instance, in some countries smallholders producing palm oil, and smallholders producing sugar, may benefit from increases in the prices of these commodities, even though they themselves are not selling into biofuel markets. A system that attempted to ascribe food security effects to individual consignments of biofuel would not be able to capture these impacts.

(iii) International law aspects

The Commission considers it acceptable, taking into consideration related international law, to include greenhouse gas impacts, biodiversity impacts and other environmental impacts in the scheme.

As shown above, it is not possible to make an appropriate link between food security impacts and individual consignments of biofuel. For this reason, it is not possible (or necessary) to assess whether such a link would be acceptable in relation to international law.

As well as raising considerable technical and administrative issues, including in relation to the difficulty of making a link to individual consignments of biofuel, the inclusion of social criteria also raises issues in relation to international law.

(iv) Assessment of possibility of biofuel production having a negative impact

Greenhouse gas emissions

Biofuels save greenhouse gas emissions because they replace fossil fuels, whose use gives rise to a high level of greenhouse gas emissions.

However, biofuel production processes give rise to emissions which have to be set against this saving.

The second column in the table in Annex 7A gives typical values for greenhouse gas savings from different biofuel production pathways, valid for the cases in which there are no effects due to land use change. These are all positive, indicating that biofuel production – whatever the feedstock and whatever the production technique – typically delivers greenhouse gas savings if there are no land use change effects.

However, these typical values are estimates of the mid-points of ranges. Data on 'inefficient' production processes are not available, and nor are data on the extent to which production takes place on land where it would lead to high N_2O emissions. It cannot therefore be excluded that production processes sometimes stray below the 0% level, reflecting situations under which biofuel production leads to additional greenhouse gas emissions rather than to greenhouse gas savings.

It is therefore concluded that while the greenhouse gas impact of biofuel production pathways is typically positive, at least in the absence of land use change, the possibility of a negative impact is sufficiently well documented to make it appropriate for this aspect to be taken into account in the design of the biofuel sustainability criteria.

It could be argued that these problems are tackled in the Commission's proposal to amend the Fuel Quality Directive[90]. But that proposal will apply only to certain biofuels – those that fuel suppliers choose to use to meet their obligations under that Directive – not to all. For example, it will not apply to biofuels that are used by bodies that are not fuel suppliers (such as the use of high-blend biofuels by bus or refuse collection services); nor to biofuel use at levels that exceed those necessary to fulfil fuel suppliers' responsibilities under the Fuel Quality Directive.

Moreover, while the proposed amendment to the Fuel Quality Directive provides incentives for the use of biofuels with good greenhouse gas performance, it does not create standards to ensure that those with the worst performance are avoided. Many public consultation respondents consider that such a requirement is essential

Biodiversity impacts and other environmental impacts

As stated in the biofuels progress report, the cultivation of agricultural crops for different purposes (including biofuel production) can cause substantial environmental damage if this cultivation takes place on inappropriate land.

It is therefore appropriate for these aspects to be taken into account in the design of the biofuel sustainability criteria. It is desirable to avoid the use of land with high biodiversity value for the production of biofuels, if this use would put the biodiversity, security of water supply, soil quality, or other environmental qualities in a significant danger.

Food security impacts

Estimation of the food security and social impact of the promotion of biofuels is a complex task. Demand for agricultural commodities to make biofuels will tend to cause their price to rise, and can also affect access to food, availability of food and stability of food supply. These factors can worsen the food security of the poorest people in the world. On the other hand, increases in food prices will be beneficial for those who earn their living from producing food.

A recent overview of the topic by a Senior Economist of the UN Food and Agriculture Organisation[91] concludes that:

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[90] Directive 98/70/EC.

[91] Schmidhuber, J., (Senior Economist with the Global Perspective Studies Unit of the UN Food and Agricultural Organisation) (2006): "Impact of an increased biomass use on agricultural markets, prices and food security: a longer-term perspective".

- The potential demand from the overall energy market is so large that it could result in a change in the overall paradigm of rapidly rising supply, increasingly saturated demand and falling real prices that has governed international agricultural markets over the last 40 years.

- Higher real prices in agriculture will have numerous effects on rural areas, rural industries and food security. They create opportunities but also new challenges. Higher real prices can help revitalise rural areas and help reduce rural poverty. The combination of higher prices and more marketable produce will raise overall revenues for agricultural households. In tandem, rural, non-agricultural households could benefit from new employment opportunities and higher wages and thus higher incomes. The positive income effect should be particularly pronounced where bioenergy production and processing is labour-intensive and access to land is relatively equitable. Overall, the effect could a global renaissance of agriculture and a revitalisation of rural areas.

- While bioenergy has the potential to arrest the long-term downward trend in real prices for food and agriculture, the effect may be limited in time and size and even a longer interruption in falling real prices may not mean a complete and permanent departure from the century-long downward trend. The current bioenergy-triggered boom could be followed by a marked bust cycle when the second generation biotech feedstocks enter the market on a large scale.

- There is a possibility of over-investment in bioenergy production.

- Concerns about a looming global neo-Malthusian scenario – a massive doomsday scenario caused by an increase of use of agricultural commodities for biofuel – are unwarranted.

- The impact on food security needs to be analysed in the context not only of higher food prices and lower availability but also in terms of rising incomes for farmers and rural areas as well as changing price variability. A priori, competition with food production will result in lower availability and an increase in food expenditures for the poor. However, many rural households stand to benefit both through higher prices for their produce and higher volumes of marketable production. As 70 percent of the poor live in rural areas, the overall net effect on food security could be positive.

- One of the challenges for the orientation of development policy is to design and implement policy measures that help ensure that the growing use of bioenergy is conducive to reducing poverty and hunger. In general this is the case when bioenergy use and processing are labour-intensive, capital-saving and technologically-saving.

In the light of the complexity of the issue, the potential benefits on offer and also the possible risks, and in the light of Schmidhuber's conclusion that the degree of benefit for the poorest people depends in part on policy choices, it is recommended that assessment of positive and negative food security impacts should be an important element in the regular monitoring of the implementation of the policy.

Having said this, it should be borne in mind that the assessment quoted above focusses on the global impact of bioenergy promotion in general. Analysis carried out by the Commission suggests that the commodity price impact of the EU's own 10% biofuel target will be on a rather small scale, compared to the impacts of other policies at the global level. Implementation of the policy will cause cereal prices to rise by 3% to 6% compared to the

2006 level. The price of sunflower seed will increase by 15% and of rape seed by 8% to 10%, while prices of animal feed will fall due to the increased availability of biofuel co-products[92].

Recent commodity price increases result from a number of factors, notably a drop in production in the main grain producing and exporting countries, increased demand for meat and dairy consumption in China, India and other developing countries, and increased interest in agricultural commodity markets from financial investors, as well as increased biofuel demand[93].

As regards the effects attributable to biofuels, in 2007 the supply shortfall of main grain producing countries was four times as large as the increasing demand for biofuels[94]. Moreover, the main source of this increased biofuel demand is the U.S. market and not the European market. There are important structural differences between the two markets. The rate of increase of biofuel consumption seen in the U.S. is faster than that needed to achieve the EU's 10% target by 2020. The market will have a full opportunity to adapt to the EU's target[95]. The food security impacts of the EU policy, both positive or negative, are therefore likely to be relatively small.

Social impacts

Biofuel promotion can be expected to have both positive and negative social impacts. For example, the contribution of biofuel promotion to a shift from dependence on the production of minerals, with the associated "resource curse", to a more widely-based form of resource production, will have a positive social impact[96], while on the other hand, there are reports to suggest that demand for biofuels has already led to land being taken away from small farmers in some developing countries.

A more in-depth analysis of the issue is not undertaken here in the light of the conclusion that it is not straightforward to link social criteria to individual consignments of biofuel and that this raises technical and administrative issues.

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[92] The impact of a minimum obligation for biofuel use in the EU-27 in 2020 on agricultural markets. Available on http://ec.europa.eu/agriculture/analysis/markets/biofuel/impact042007/index_en.htm.

[93] Von Braun, J. (2007): "The world food situation: new driving forces and required actions", presentation to CGIAR annual meeting, Beijing, 4th December 2007.

[94] 'OECD says biofuel impact on food prices is overplayed', 15 January 2008, http://uk.reuters.com/article/environmentNews/idUKL1419899820080114.

[95] The price effect of the EU's biofuel target is small because it the target is set at a level that takes into account the EU's growing ability to assign agricultural resources to biofuel production. The same will not necessarily be true of biofuel promotion in all regions of the world. A recent study (December 2007) undertaken by the International Food Policy Research Institute (IFPRI), forecasts considerable increases in feedstock prices including cassava, maize, oilseeds, sugar and wheat. In a modest scenario (mainly based on existing investment plans worldwide) IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) forecasts world price increases of 11.2 % for cassava, 26.3% for maize and 18.1% for oilseeds and 8.3% for wheat by 2020. In a more widespread biofuel expansion scenario prices for maize and cassava, both important food crops in developing countries, are forecasted to rise by 71.8% for maize and 26.7% for cassava.

[96] Biofuels replace petroleum-based fuel. The "resource curse", under which dependence on the production of minerals such as oil or diamonds leads to corruption, rent-seeking and low growth in the remainder of the economy, has been widely documented (see for example Stevens, P. and E. Dietsche (2008): "Resource curse: An analysis of causes, experiences and possible ways forward", in Energy Policy 36, pp 56 – 65; and Nafziger, E. W. (2006): “Economic development”, 4th edition).

Because the inclusion of social criteria raises technical issues, administrative issues and issues connected with international law, it is not recommended to include social criteria in the sustainability scheme. Instead, it is recommended that assessment of social impacts play an important part in the Commission's regular reporting on the implementation of the EU policy of biofuel promotion.

The recommendation not to include social criteria in the scheme should not be taken to mean that the Commission does not take seriously the social issues relating to agriculture in developing countries. The Commission is active in this area through numerous development cooperation instruments and actions. For example,

promoting awareness internationally with potential partner countries and stakeholders on the contents of the EU land policy guidelines[97] in the implementation perspective (e.g. work carried out within the International Land Coalition, at the level of the Global Platform for Rural Development and within the Commission on Legal Empowerment of the poor). This includes cooperation and joint work with World Bank, FAO and IFAD.

at national, regional and continental level providing support to partner countries and organisations seeking for support in designing and implementing their land reforms, within the EC development cooperation programmes (e.g. support to the African Union Commission in their work to define a land policy framework for Africa, support to land reform process in Namibia and Bangladesh and initial involvement in land related discussions in the SADC region).

increasingly supporting decent work related issues through its external assistance programming (employability (formal and non-formal vocational training, self-employment, and employment services), social funds, social protection, social security and social safety nets) which are included in the respective programming documents either as focal sectors or are mainstreamed in non social sectors (infrastructures, environment etc.).

(v) What aspects of the impact of producing biofuels should the sustainability criteria cover? -conclusion

The assessment above has shown that it is not feasible to associate food security impacts with individual consignments of biofuel. It is also not recommended to include social criteria, for the reasons given above. In the light of this analysis, it is **recommended to proceed as follows**:

i) Criteria for greenhouse gas impacts, biodiversity impacts and other environmental impacts should be included, if technically feasible, and should be applied to individual consignments of biofuel

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[97] After the Commissions review of its approach to the external dimension of rural development policy in 2002 - COM(2002) 429, the 2004 common policy document and guidelines (EU land policy guidelines) supported land policy reforms in developing countries and aim to provide operational guidance for EU donors when appraising interventions in support to land policy and administration design and implementation in developing countries.

ii) Because the sustainability criteria will then relate only to environmental aspects, they should be described as environmental sustainability criteria

iii) The Directive should also provide for regular monitoring and reporting of the overall food security impacts and social impacts (positive and negative) of the EU policy of biofuel promotion.

6.7.1.2. How should the impact of producing biofuels be measured?

(i) Introduction

It follows from section 6.5.7.1.1 that it would be appropriate, if technically feasible, for the Directive to lay down environmental sustainability criteria covering the following aspects of biofuel production:

- greenhouse gas impacts
- biodiversity impacts
- other environmental impacts.

In assessing the technical feasibility of including such criteria, a key issue is whether it is possible to devise reliable ways of measuring these impacts. The availability of such measurement tools has an important influence on the character of the criteria that can be laid down.

This section looks into how the three impacts can and should be measured. It concentrates on assessing the ability of the available measurement techniques to fulfil criteria of reliability.

(ii) Measurement of greenhouse gas impacts

In recent years a wide range of methods of calculating the greenhouse gas impacts of fuels have been devised. Differences in method have sometimes led to significant divergence in results.

The Commission's original thinking was to use, in an unmodified form, the method developed in the JRC-EUCAR-CONCAWE well-to-wheel study (the "JEC Consortium")[98]. This was the approach that the Commission proposed in its consultation exercise on the biofuel aspects of the Directive.

In their responses to the consultation, however, stakeholders from the biofuel and agricultural sectors objected to this proposal, raising a number of points concerning both methodology and data. The Commission therefore brought together representatives of these sectors with JRC, CONCAWE and EUCAR to work intensively on the methodological issues (as well as data improvements). Drawing on this work, a detailed analysis was carried out of methodological options, and a set of firm conclusions were drawn. The main conclusions are in the box; the full analysis, with full comparison of options, is in Annex 7

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[98] JRC is the Commission's Joint Research Centre. EUCAR and CONCAWE are research bodies linked to the European motor and oil industry respectively. Study available at http://ies.jrc.cec.eu.int/wtw.html.

BOX: Recommended methodology for assessing greenhouse gas impacts: main points

- The same methodology should be used for the calculation of greenhouse gas impacts of transport fuels under the Directive on the promotion of energy from renewable sources and under the proposed amendment to Directive 98/70/EC (the Fuel Quality Directive).

- The methodology should take into account greenhouse gas emissions throughout the processes of production and use of fuels, including the effects of land use change.

- For the purpose of comparing the global warming impact of different greenhouse gases, the time horizon should be taken as 100 years, without discounting of the future relative to the present.

- To establish the greenhouse gas saving from fuel other than petrol or diesel, emissions from their production should be compared with actual average emissions from petrol and diesel consumed in the EU. Data on actual average emissions from petrol and diesel should be derived from fuel suppliers' reporting under the future amended version of Directive 98/70/EC. Until these data are available, the value used should be 83.8 gCO_{2eq}/MJ.

- Emissions should be divided between fuels and their co-products using allocation by energy value. All co-products, including electricity[99], should be taken into account for the purposes of this calculation, except for agricultural crop residues. Material that is used in the biofuel production process should not be considered to be a co-product for this purpose.

- In accounting for the excess electricity produced by fuel production systems that use cogeneration, the size of the cogeneration unit should be assumed to be the minimum necessary to supply the heat that is needed to produce the fuel. The greenhouse gas emission savings associated with this excess electricity should be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

- In accounting for land use change, it should be assumed that if not producing biofuels, the land would keep the same use as it had on a reference date. The carbon stock effect of land use change should be accounted for over a 20 year period, without discounting.

- N_2O emissions from soil should be included.

- The methodology should include default values. In assessing greenhouse gas emissions from fuels, fuel suppliers should be able either to use an actual value or to use a default value given in the Directive.

It can be seen that in order to apply this method, it is necessary to set default values for biofuels.

The approach to the setting of default values that is proposed in Annex 7 is that they should:

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[99] Except when electricity is produced by fuel production systems that use cogeneration and where the fuel used for the cogeneration is a co-product other than an agricultural crop residue.

(a) be set at a level that is typical of normal production processes where the contribution to overall emissions is small, or where there is limited variation, or the cost or difficulty of establishing actual values is high;

(b) be set at a conservative level in other cases.

In the case of biofuels, emissions from transport and distribution fall into category (a) because the contribution they make to overall emissions is small.

Emissions from cultivation fall into category (a) because, although the contribution to overall emissions is high, as is variability, the difficulty of establishing actual values is also high, in particular because of the difficulty of assessing N_2O emissions.

Emissions from processing fall into category (b) because their contribution to overall emissions is high and variability is also high.

It follows that in the calculation of default values, conservative values should be used for emissions from processing, while typical values should be used for emissions from other parts of the production process.

In this context, and in the absence of specific data on inefficient production processes, It is assumed that an increment of 40% in emissions from processing represents an appropriate degree of conservatism in establishing the conservative elements of default values.

Thus, it is recommended to calculate default values on the assumption that emissions from processing are 40% higher in the default case than in the typical case.

Default values calculated according to with this recommendation, and with the methodology in Annex 7, are shown in Annex 7A.

(iii) Measurement of biodiversity impacts

It is concluded in section 6.5.7.1.1 (iv) that it is desirable to avoid the use of land with high biodiversity value for the production of biofuels, if this use would put the biodiversity in danger.

The key measurement task is therefore the identification of such land.

Forest habitats undisturbed by human intervention hold species that are especially diverse and often threatened elsewhere in their range[100], as do certain types of grassland[101]. These habitats can be reliably identified.

Beyond this statement, which can command a relatively wide range of support, there is little consensus about how the biodiversity of habitats should be measured.

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[100] http://www.biodiversityhotspots.org/xp/hotspots/caribbean/Pages/biodiversity.aspx
http://www.edinburgh.ceh.ac.uk/biota/Archive_Genetic/4904.htm
http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=104607;

[101] Robin White *et al*. Pilot analysis of global ecosystems: Grassland Ecosystems, 2000.

(iv) Measurement of other environmental impacts

It has proved impossible to identify a data source that could permit the definition of appropriate substantive criteria for other environmental requirements, such as those relating to soil and water management, in a reliable form.

(v) Conclusion

Based on the analysis above, the following conclusions can be drawn:

- It is possible to measure greenhouse gas impacts in a reliable way; an appropriate methodology has been devised, following extensive stakeholder consultation, and is set out in Annex 7.
- It is possible to identify certain high-biodiversity habitats in a reliable way, but the scope of this is limited.
- It is not possible to define other environmental impacts in a reliable way.

6.7.1.3. What should be the required minimum level of performance for biofuels?

(i) Introduction

Section 6.5.7.1.1 concluded that it would be appropriate, if technically feasible, for the Directive to lay down environmental sustainability criteria covering the following aspects of biofuel production:

- greenhouse gas impacts
- biodiversity impacts
- other environmental impacts.

Section 6.5.7.1.2 concluded that the available measurement techniques for greenhouse gas impacts fully comply with the criterion of reliability. Those for biodiversity do so only to a limited extent. Those for other environmental impacts do not do so. This assessment conditions the nature of the minimum requirements that can be laid down in each case.

Minimum requirements for each of the three impacts are examined below. Two general questions relating to land use change are also addressed:

- what should be the cut-off date for land use change requirements?;
- do further requirements need to be set to take into account the issue of "indirect land use change"?

(ii) Minimum requirements for greenhouse gas emissions

<u>Design of the requirements: options assessed</u>

Using the methodology in Annex 7, it is possible to ascribe a quantified greenhouse gas saving to each consignment of biofuels. This figure can be used as the basis for setting minimum requirements. This leads to the:

First design question: should the greenhouse gas requirement take the form of a single "cut-off" value, or should it take the form of a continuous scale, under which better-performing biofuels receive greater credit?

The conclusion reached is that the requirement should take the form of a single cut-off value. This leads to the:

Second design question: what should the cut-off value be?

The greenhouse gas impact of land use change is taken into account in the figures calculated using the methodology in Annex 7. This leads to the:

Third design question: is it sufficient for land use change to be taken into account in the calculation of greenhouse gas saving values for each consignment of biofuels, or should there also be a specific requirement relating to conversion of certain types of high-carbon stock land?

The conclusion reached is that there should also be a specific requirement relating to the conversion of certain types of high-carbon-stock land. This leads to the:

Fourth design question: what types of land should be subject to this additional, specific requirement?

<u>First design question: Should the greenhouse gas requirement take the form of a single "cut-off" value, or should it take the form of a continuous scale?</u>

The choice here is between:

- a cut-off, limiting eligibility to biofuels that achieve a minimum rate of greenhouse gas savings; or

- a system of bonuses or continuous scale of incentives, giving higher incentives to biofuels with higher savings.

In evaluating the choice between these two instruments, the starting point for analysis is that the EU's renewable energy policy in general, and its biofuel policy in particular, have multiple objectives, including:

- reduction of greenhouse gas emissions

- promoting security of energy supply

- rural development in the EU and in developing countries

- industrial and technological development

Different types of biofuel contribute to each of these objectives to a different degree.

It could be argued that the optimal approach would be to design a scheme that quantifies the contribution that each consignment of biofuel makes to each of the objectives of the EU's renewable energy policy, and combines these quantified contributions into a single score. Incentives could then be modulated as a function of this score.

However, there is no consensus about how contributions to most of the objectives listed above should be measured. This would probably be a decisive argument against the approach even if it were to be applied only to domestically produced biofuels. Since the biofuel sustainability scheme will also affect imported biofuels, it is even more important for its requirements to be based on scientific principles. This approach is therefore rejected.

Unlike the other objectives, contributions to the objective of reducing greenhouse gas emissions can be measured with a reasonable degree of reliability. It could therefore be argued that the "second best" option would be to design a sustainability scheme that modulates incentives for biofuels, giving gradually increasing incentives as the level of greenhouse gas savings increases.

This option is also not recommended, for the following reasons:

a) It would lead to a distortion of incentives to the detriment of those biofuels that make a lesser contribution to greenhouse gas reduction but a larger contribution to other objectives. For example, it would do little or nothing to encourage the development of second-generation biofuels (an important aspect of industrial and technological development). As Table 32 shows, this incentive would still leave second-generation biofuels at the bottom of the 'cost-effectiveness league' from the point of view of fuel suppliers. More targeted incentives are needed.

c) The Commission has proposed to amend the Fuel Quality Directive to incorporate provisions that would make incentives for road transport fuels (including biofuels) a function of their greenhouse gas savings. The Directive on the promotion of the use of energy from renewable sources should not duplicate this.

d) A single cut-off value decreases the administrative burden. With one cut-off value, the number of operators required to prove the performance of their biofuels will be limited. With a series of cut-off values, with differentiated objectives, the number of operators providing actual values for the performance of their biofuels would greatly increase, adding to the complexity of the scheme, both for operators and the Member States authorities charged with checking compliance.

Table 32 Assessment of the impact on the attractiveness of second-generation biofuels (shown in italic) of a system under which incentives for biofuels are proportionate to their greenhouse gas savings

Biofuel	**Cost of GHG saving, €/tCO$_{2eq}$**
ethanol from sugar cane	20
biodiesel from palm oil	90
ethanol from wheat	90
biodiesel from rape	130
ethanol from sugar beet	160
second-generation ethanol (cellulosic) from straw	*160*
second-generation BTL from farmed wood	*180*

Source: Data derived from review of economic and environmental data for biofuels progress report. (Note: the cheapest available production technique is assumed; prices assume more competitive agricultural markets; prices are rounded to the nearest €10); greenhouse gas *savings calculated using energy allocation method.) Assumed oil price: $60/barrel. Assumed exchange rate: €1=$1.20*[102].

The option of a simple cut-off, ensuring that biofuels used to meet EU targets achieve at least a minimum level of greenhouse gas savings, is therefore retained in the accompanying proposal for a Directive.

Second design question: What should the cut-off value be?

It has been concluded that it is appropriate for the Directive to include a cut-off value for the level of greenhouse gas savings. Biofuel production processes that do not deliver this level of savings will not meet the minimum sustainability criteria.

Many public consultation respondents shared the view that such a requirement is essential. The public consultation document floated a possible minimum value of 10%; most respondents took the view that this was too low, suggesting values between 25% and 80%.

To evaluate the appropriate level for the cut-off value, it is necessary to analyse what the effect of the cut-off (in combination with the set of default values) will be.

In practical terms, biofuel production processes will fall into three groups:

(a) Those whose default value is above the cut-off.

(b) Those whose default value is below the cut-off, but which are capable of complying with the cut-off.

(c) Those that – on the evidence of the typical value - are not likely to be capable of complying with the cut-off under any conditions.

Operators of biofuel production processes in category (a) will be able to demonstrate their fulfilment of this sustainability criterion with only minimal effort (in most cases they will only need to document the nature of the biofuel and the type of feedstock used).

Operators of production processes in the category (b) will need to make more effort. They will need to provide more detailed evidence of their production practices (this could cover agronomic practices; transport modes and distances; or quantities and types of process fuel used), and may also have to change these practices to fulfil the criterion.

Operators of production processes in category (c) will probably be unable to comply with this sustainability criterion.

The default values and typical values are shown in Annex 7A. In combination with these values, the position of the cut-off will determine which biofuel production processes fall into which group.

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[102] Note: at higher euro-denominated oil prices, such as those prevailing at the time of writing, the extra cost of second-generation biofuels is an even higher multiple of the extra cost of first-generation biofuels. It should be pointed out that the expected benefits of second-generation biofuels are not limited to their greenhouse gas performance. They are also expected to bring benefits in terms of other environmental impacts; supply diversification; efficiency of land use; and technological development. Since they are not yet on the market, full analysis of their impact is not possible at this stage.

In setting the level of the cut-off, three options were considered:

F. Set the cut-off at a level that biofuels from most or all of the prevailing production pathways can fulfil, albeit in some cases with additional effort.

G. Set the cut-off at a level that requires additional effort from typical first-generation biofuels consumed in the EU, but not at a level with which most of these biofuels are unlikely to be able to comply.

H. Set the cut-off at a level that only the best-performing current biofuels will be able to meet.

These options are assessed on the grounds of greenhouse gas impact and of feasibility.

Option A would imply a cut-off of about 10-15%. It would mean that the default value for nearly all biofuels would be above the cut-off. As a consequence, the real impact on greenhouse gas emissions would be limited. This option is therefore rejected.

Option C would imply a cut-off of 50-60% or more. Biofuels targets would have to met primarily through straw-fuelled ethanol production processes; sunflower biodiesel; and sugar cane ethanol. This approach would not be feasible because the potential availability of sunflower biodiesel is limited; and an approach that relies purely on ethanol production without production of biodiesel would not make feasible the achievement of the target, taking into account the high and growing share of diesel in the EU fuel mix.

In the light of this analysis, Option B is recommended. A cut-off in the range of 30-40% would be an appropriate level to require additional effort from typical first-generation biofuels consumed in the EU, without setting the cut-off at a level with which most of these biofuels are unlikely to be able to comply.

A cut-off in the range of a minimum greenhouse gas saving of 30-40% is therefore recommended.

The table shows the estimated **greenhouse gas impact** of setting the cut-off at different levels[103].

	GHG savings from 10% target in	**additional**

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[103] This estimate took as its starting point the Commission's forecast of the mix of biofuels likely to be used in 2020 (see: *The impact of a minimum obligation for biofuel use in the EU-27 in 2020 on agricultural markets*, op. cit.) and the typical greenhouse gas savings in Annex 8A. It was estimated that half of the current EU wheat bioethanol plants use lignite as process fuel and the other half use natural gas in CHP, and that current typical palm oil production does not prevent emission of methane at the mill.
It was assumed that:
At a 10% cut-off:
Wheat ethanol produced by using lignite fuel will cease to be used and instead all wheat ethanol will be produced by using natural gas in CHP as fuel.
At a 35% cut-off, in addition:
Palm oil producers will improve their process and not emit methane any more.
At a 40% cut-off, in addition:
All sugar beet ethanol and rapeseed biodiesel producers will have to provide actual data because they will not be able to use the default values. Some but not all of them will have to improve their process. It is assumed that this results in a 5% higher average life-cycle performance for sugar beet ethanol and rapeseed biodiesel.

	2020 (Mt CO2eq)	**savings**
no cutoff	75.8	
10% cutoff	81.8	6.1
35% cutoff	82.7	7.0
40% cutoff	84.8	9.0

Higher levels are not shown because it is not considered feasible to fulfil the 10% target with any level of confidence if the cut-off is set at a significantly higher level.

There is no consistent tendency for biofuels with a poor greenhouse gas performance, such as those produced from wheat using lignite as process fuel, to cost less than those with better performance[104]. Therefore, the cost impact of setting the cutoff at the different levels shown in the table is estimated to be negligible.

Third design question: Should there be a specific requirement relating to conversion of certain types of high-carbon stock land?

Some land types have such high carbon stock that their conversion for the production of biofuels will take too great a period of time to bring about a net positive effect, given the urgency of action in respect of climate change. For these land types it is never useful for economic operators to do the burdensome calculations required by the method in Annex 7 to find out whether the land can be converted for biofuels production or not. For administrative simplicity, and so the scope of the sustainability criteria is clear, it is recommended to include in the sustainability scheme an absolute rule against the conversion of land from certain high-carbon-stock land uses.

Fourth design question: What types of land should be subject to this additional, specific requirement?

Wetlands are the areas with the highest carbon stock per area on a global scale (average 686 ton carbon per hectare)[105]. Forests are the second highest category (average 275 ton carbon per hectare). Grasslands come third (average 181 ton carbon per hectare); arable land has on average 82 ton carbon per hectare. These figures are however subject to very significant variations.

When comparing these figures, it is clear that conversion of wetlands for the production of raw materials for biofuels leads to such a high loss of stored carbon that it can never result in the biofuel meeting a cut-off value and should be ruled out. This also applies to forests.

Given the significant variability that lies behind the global averages quoted in the first paragraph, the figures do not justify a rule against the conversion of grasslands or other land types.

It is therefore recommended that the specific rule against the conversion of land from high-carbon-stock land uses should apply to wetland and forest, but not to other land types. Account of the conversion of other types of land-use should be included in the calculation of greenhouse gas emissions.

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[104] See "Review of economic and environmental data for the biofuels progress report", op. cit.

[105] IPCC special report: Land Use, Land Use Change and Forestry, Summary for policy makers, 2000.

Conclusion

It is recommended to include in the scheme the following greenhouse gas requirements:

(i) A minimum greenhouse gas saving from biofuels of 30-40%;

(ii) An absolute rule against the conversion of land that has the status of wetland or forest.

(iii) Minimum requirements for biodiversity

In the light of the analysis in section 6.5.7.1.2(iii), it is recommended to lay down an absolute rule against the use of raw material from land that has the status of forest undisturbed by human activity and also for certain types of grassland.

These are not the only types of land with high biodiversity that could be put at risk by the harvesting of raw material for biofuel production.

However, as argued in section 6.5.7.1.2(iii), it has not been possible to identify such land uses according to reliable criteria. In the absence of such criteria, decisions to classify certain pieces of land as falling into this category would be arbitrary.

As a fall-back, it is therefore recommended to place in a second category those pieces of land that have been designated for nature protection purposes by these states themselves.

The recommended option is therefore to set biodiversity criteria on two levels.

Biofuels produced from raw materials from land that fell into the highest, scientifically defined category – forest undisturbed by human activity, and certain types of grassland - would never fulfil the criteria of the sustainability scheme.

Biofuels produced from raw materials from land in the second category, consisting of governmentally-designated protected areas, would fail to fulfil the criteria unless it could be shown that the production of the raw material did not interfere with these purposes.

(iv) Minimum requirements for other environmental impacts

As set out in section 6.5.7.1.2(iv), reliable criteria for other environmental impacts could not be identified.

In the light of this, it is not possible to lay down rules based on substantive requirements that are the same for every location.

As a fall-back, the option was explored of requiring fuel suppliers to show that they fulfil whatever requirements relating to good agricultural practice are laid down in the national legislation of the country where the raw materials are produced.

In principle, it would be desirable to apply such a rule in relation both to EU production and to raw materials produced in third countries. However, this option was rejected as far as third countries are concerned because it would be difficult to put into practice. Fuel suppliers would have to present to the verifier the relevant passages from national law; in addition, they would have to present evidence (which would presumably need to vary in nature from one producing country to another) of their compliance with these requirements.

These objections do not hold in relation to the European Union. Here, the "cross-compliance" system already provides for the verification of certain requirements laid down by EU environmental law. Extension of these rules to biofuel production not already caught by the cross-compliance system can be seen simply as a tidying-up process.

It is therefore recommended to apply this approach, but to limit its application to the EU.

(v) Cut-off date for land use requirements

Section (ii) recommends as a minimum requirement that biofuel should not be made from raw material cultivated on land that was wetland or forest before a certain cut-off date, and is wetland or forest no longer, and also presents a land use cut-off date as part of the general methodology for calculating greenhouse gas impacts. Section (iii) recommends as a minimum requirement that biofuel should not be made from raw material cultivated on land that was forest undisturbed by human activity, or designated for nature protection purposes (with certain exceptions), again before a certain cut-off date[106].

It is therefore necessary to choose a cut-off date. Three options were examined:

A. 1992 (the date of the UN Framework Convention on Climate Charge);
B. May 2003 (the date of adoption of Directive 2003/30/EC);
C. January 2008 (the date of adoption of the present Commission proposal).

It is considered that it was only in January 2008 that the specific nature of the EC's policy towards the sustainability scheme would become clear. Options A and B are therefore rejected, and option C is recommended.

(vi) Are additional land use change criteria needed?

Some commentators have argued that a biofuel sustainability scheme ought to include additional measures to address "indirect land use change".

This expression refers to the fact that the land use impact of a change in demand for an agricultural commodity is not fully described by a description of the piece of land on which the commodity is produced. Repercussions can be expected on the use of land elsewhere.

In assessing this question, the starting point is to consider what form these repercussions take.

Some commentators imply that each hectare of land devoted to the cultivation of crops for the biofuel market will have to be offset by finding a hectare of land, somewhere else, to produce the food that would (it is suggested) otherwise have been produced on the biofuel-producing land.

However, citing the UN Food and Agricultural Organisation, "Yield increases and increased cropping intensity but not arable land expansion form the lion's share of sources of growth in LDC crop production from 1960 to 2005, and are expected to dominate growth from 2005 to 2030." There is a clear link between demand for agricultural commodities, their prices, investment in agriculture and agricultural productivity[107]. Thus, it can be expected that the

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[106] The difference between the two criteria is that the first applies to land that was in certain uses at the cut-off date and is not in those uses when the biofuel raw material is produced. The second applies to land that was in certain uses at the cut-off date, even if it is still in those uses at the time the biofuel raw material is produced.

[107] Nafziger, op. cit.; *The Economist*, op. cit; Von Braun, op. cit.

main impact of increased biofuel demand will be a further increase in productivity, not an increase in the quantity of land used for agriculture.

Thus, even in the absence of a biofuel sustainability scheme, if a is the total amount of land used for the production of crops for biofuels, then the global increase in the amount of land devoted to agriculture can be expected to be a/b, where b is positive and greater than 1. The historical trend, based on data from the UN Food and Agriculture Organisation for 1980 to 2006[108], is that approximately 70% of the global increase in oil crop production has come from increases in productivity and 30% from increases in land devoted to these crops (this means b=3.3). For cereals over the same period, all of the increase in production came from increases in productivity and none from increases in land devoted to these crops (this means b=infinity).

Where there is a change in the use of land, it will nevertheless have negative environmental consequences in some cases.

These negative effects could be taken into account in the sustainability scheme in two ways:

A. Imposing a penalty on biofuels that come from land where such change has in fact taken place (the penalty should be equivalent to the full effect of this land use change); or

B. Imposing a penalty (equivalent to the average environmental effect of multiplied by a/b) on all biofuels (on the basis that it is the *system-wide effect* that should be taken into account, not the effect of the *individual consignment of biofuel*).

It is important to appreciate that these are alternatives, not potential complements. If one is adopted, the other should not be. To adopt both options at the same time would impose a disproportionate burden on biofuel producers.

The first option is the one recommended in sections (ii) and (iii) above dealing with greenhouse gas emissions and with biodiversity

This option ensures that individual acts of land conversion to grow biofuel raw materials would face a clear disincentive; the second option does not.

Option B is therefore rejected.

(vii) Conclusion

It is recommended to lay down the following minimum environmental sustainability requirements for biofuels:

(i) A minimum greenhouse gas saving of 30-40%

(ii) A rule against the use of raw materials from land that had the status in January 2008 of wetland or forest and no longer has this status;

(iii) A rule against the use of raw materials from land that had the status in January 2008 of forest undisturbed by human activity or of certain types of grassland;

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[108] FAOSTAT

(iv) A rule against the use of raw materials from land that had the status in January 2008 of an area designated for nature protection purposes, unless it can be shown that the production of biofuels did not interfere with those purposes;

(v) Extension of the 'cross-compliance' environmental criteria to all agricultural raw materials produced in the EU and used to make biofuels.

6.7.1.4. What should be the consequences of failing to meet the required minimum level of performance?

Section 6.5.7.1.3 recommends minimum requirements for biofuels. It is necessary to consider what consequences would follow for biofuels which fail to meet these requirements. The following options were explored:

A. Suppliers will be required to report on whether biofuels meet the requirements, but will not suffer any adverse consequences if they do not meet them

B. Biofuels that do not meet the minimum requirements will not count towards national targets under the Directive on the promotion of renewable energy

C. In addition to B, biofuels that do not meet the minimum requirements will not be eligible for financial support for the consumption of biofuels and will not count towards national biofuel obligations

D. In addition to B and C, biofuels that do not meet the minimum requirements will not be eligible for financial support for the production of biofuels

E. Biofuels that do not meet the minimum standards cannot be used in the EU.

Option A (a reporting requirement, without consequences for failing to meet standards) would impose an administrative burden without making a significant practical difference. For this reason, this option is not supported.

Under option B, biofuels that did not meet the minimum requirements would not count for national biofuel targets – but could still receive financial support and count for biofuel obligations. This would appear illogical and would not contribute to the clarity and legibility of the scheme. For this reason, this option is not supported.

Option C appears to be both practical and effective.

It should be noted that option C regulates financial support (such as exemptions from taxes on motor fuels) only where this support relates to the *consumption* of biofuels.

Under option D, by contrast, financial support for the *production* of crops would also be regulated. In principle, it would be possible for the EU to prevent administrations within the Union from giving such support if used for biofuels that do not meet the minimum requirements. However, the EU could not require third country administrations to do the same. Thus, it would not be possible to apply this rule in a way that would treat all biofuels in the same way, wherever they or their feedstock is produced (domestically produced and imported biofuels would not be treated equally). This does not appear desirable. For that reason, option D is not supported.

Option E would amount to a ban on the marketing of certain biofuels, both imported and domestic. This is a stronger restriction than option C (under which the minimum standards act as conditions for eligibility for public support) and does not appear to be a necessary or proportionate measure at this stage in the development of the market for biofuels.

Option C is therefore the option recommended. This was the approach suggested in the consultation document; it did not receive adverse comments.

6.7.1.5. How should performance be verified?

(i) Introduction

Section 6.5.7.1.3 recommends minimum requirements for biofuels. Section 6.5.7.1.4 makes recommendations for the consequences that should occur when biofuels fail to meet these criteria. In order to ensure that these consequences do in fact occur, it is necessary to put in place a system to ensure that biofuels' performance is verified.

Two questions were explored:

- Where should responsibility for verifying compliance lie?

- What type of evidence should fuel suppliers be required to provide?

(ii) Where should responsibility for verifying compliance lie?

Three options were assessed:

A. Solely a Member State responsibility
B. Member State responsibility with supporting framework at EU level
C. Solely an EU responsibility

In assessing these options, a starting point is to note that as outlined above, non-compliance with the criteria will have three consequences:

i) The biofuel will not be eligible for financial support for the consumption of biofuels.
ii) The biofuel will not count towards national biofuel obligations

iii) The biofuel will not count towards the Member State's compliance with the EU target for the market share of renewable transport fuels.

The commonest form of financial support for the consumption of biofuels is for Member States to exempt fuel suppliers from taxes that they normally pay on the fuel they sell. Biofuel obligations are also imposed on fuel suppliers. Member States will normally use data from fuel suppliers to measure the volume of biofuels (as well as conventional fuels) placed on the market. It is therefore evident that fuel suppliers are the economic operators on which the primary burden of demonstrating compliance will fall.

(This is not to say that fuel suppliers will be the <u>source</u> of all the information needed to demonstrate compliance. Often, fuel suppliers will need to obtain compliance information from other operators further up the production chain. But Member States' direct relationship will be with the fuel suppliers; in most cases it will be for the fuel suppliers to ensure, and take responsibility for, the reliability of the information that they in turn obtain from others.)

Through the fuel excise duty system, all Member States already require systematic reporting of fuel-related information by fuel suppliers. The most efficient arrangement will be for this reporting to be extended to cover sustainability aspects, rather than for a separate administrative structure to be developed to deal with sustainability aspects alone. On grounds of minimising administrative effort, this points towards responsibility for verifying compliance lying with Member States. Option C is therefore not supported.

In order for compliance to be verified, economic operators will have to make claims about matters such as the geographical location of the land on which the raw materials for biofuel production were cultivated; the nature of the raw material used; or the energy source used in the biofuel production process. Under option A, each Member State would have to develop its own system for verifying such claims. This would lead to a good deal of duplication of effort. Under option B, a framework would be established to permit and facilitate the standardisation of these systems. The Directive would put in place a procedure to accept that sustainability schemes as meeting adequate standards of accuracy, reliability and fraud-resistance. Once a scheme had been accepted in this way, all Member States would be obliged to accept evidence from this scheme as conclusive proof of compliance with the sustainability criteria in question.

If such standardisation is permitted, and even if it is not imposed, there will be a good chance that it will in fact take place as a result of choices made by administrations and firms. Member States will have an interest in such standardisation, because it will reduce the need for them to devise and implement verification schemes at national level. Multinational economic actors will also have an interest in it, in order to avoid the costs associated with compliance with different verification systems in each Member State. It can therefore be expected that option B will lead to efficient verification at a lower administrative costs than either option A or option C. **Option B is therefore the recommended option**.

(iii) Type of evidence to be provided by fuel suppliers

Three options were assessed:

A. Under the **identity preservation** or **track and trace** method, fuel suppliers must be able to show that the consignment of raw material or biofuel in question is the raw material or biofuel whose sustainability characteristics are described in associated documentation;

B. Under the **mass balance** method, fuel suppliers must be able to show that the consignment of raw material or biofuel in question was withdrawn from a physical pool into which the raw material or biofuel whose sustainability characteristics are described in associated documentation had previously been added; and that the withdrawn quantity of raw material or biofuel with which this documentation is associated does not exceed the added quantity;

C. Under the **book and claim** method, fuel suppliers must be able to show that a quantity of raw material or biofuel equal to the quantity in the consignment in question, and having the sustainability characteristics described in associated documentation, has been produced somewhere in the world; and that this documentation has not been and will not be associated with any other consignment of biofuel for the purposes of sustainability verification.

In assessing these options, two criteria were used: effectiveness (that is, the ability of the regime to deliver greenhouse gas and biodiversity impacts) and administrative costs.

Effectiveness

In assessing effectiveness it is important to note that the purpose of the sustainability scheme is to increase sustainability.

This is only likely to happen if the scheme induces economic agents to behave differently than they way in which they would have behaved in the absence of the scheme.

Economic agents respond to price signals. Therefore, the scheme will only increase sustainability if it sends a price signal that rewards the adoption of more sustainable behaviour.

This will only be able to happen if a separate, premium price market is created for raw materials feeding into the biofuels market.

This will not occur under the book and claim method. Instead, the globally large number of producers of agricultural commodities who already fulfil the proposed sustainability criteria (and who could, in fact, fulfil much more stringent criteria) will be able to obtain certificates that can be sold to European biofuel producers – while continuing to sell their physical products in the (predominantly non-European) markets they currently serve.

Both the identity preservation and the mass balance method permit the establishment of a premium price market for raw materials/biofuels that meet the sustainability criteria. The identity preservation market could be expected to create a higher price premium, because the entry cost for the method (the cost of creation of a entirely separate method of storage and transport for material that meet the sustainability criteria) is higher.

Administrative costs

The verification of compliance with the sustainability scheme for biofuels sets out the requirement for Member States to require fuel suppliers to provide evidence of compliance with the biofuels sustainability scheme. The administrative costs for operators to comply, given in Annex 10, consist of three parts: produce the data in those cases where they do not have adequate data available; keep records of these data with the biofuel and raw material consignments; independent verification of the submitted data.

The estimates of administrative costs are based on the assumption that there are an estimated 300 transport fuel suppliers (large and small) and that there are eight operators are involved in each biofuel chain. This number likely underestimates the number of operators at the cultivation level (this depends on the size of the actual farms and plantations involved). However, the possibility to make use of default values greatly reduces the amount of actors that need to produce actual data. In addition, farmers can combine their efforts and use the options of providing regional data and use certification schemes.

When it comes to transmitting evidence of the verification to the fuel supplier (this has to be done for each consignment of biofuel and consists of filling forms and tables) the assumed number of producers may again underestimate the number the producers at the cultivation level. However, whereas other producers would have to do this task frequently, e.g. twice a week, farmers would generally have to do this much less frequently due to the nature of the activity of cultivation.

When it comes to independent verification the number of producers involved may indeed be higher and a higher estimate is therefore used. Even so, especially when making use of certification schemes, at a cultivation level, independent verification could be combined for several producers. In addition, there may be certain producers (logistic companies, small farms) where the verification will take a considerably shorter time than average.

Since it is difficult to estimate the size of these effects in practice, the margin of error is high.

The estimated administrative costs of transmitting evidence of the verification to the fuel supplier are dependent on which option is used. The cost estimates for the three methods are shown in table 33.

Table 33 Cost of transmitting evidence of the verification to the fuel supplier

	Estimated costs €/toe	**Estimated absolute costs 10% target[109] € million per year**
Identity preservation	24[110]	792
Mass balance	0.44[111]	15
Book and claim	0.11[112]	3.6

These estimates do not take into account the cost of avoiding fraud. This will imply costs that are somewhat higher than those shown above. The book and claim method is more open to fraud. Its verification costs might be higher than for the other two in order to prevent this. This implies that its cost advantage over the other methods would not be as great as shown in the table.

If the book and claim method were to be combined with the other two methods, the risk of fraud would be even greater. A producer could sell a book and claim certificate to a fuel supplier while selling its production as sustainable under one of the other systems. Prevention of this practice would induce further additional verification costs.

Conclusion

The book and claim method has the disadvantage of lower effectiveness. The identity preservation method has the disadvantage of very high cost. The mass balance method is not quite as cheap as the book and claim method, but effective (though not as effective as the identity preservation method). On this basis, **it is recommended to require fuel suppliers to use the mass balance method.**

However, in the light of the lower costs/administrative burden of the book and claim method, it would be appropriate for the Commission to keep under review the possibility of also allowing its use, perhaps for individual feedstocks where the market coverage of sustainability schemes is sufficient to dispel the concerns about effectiveness referred to above.

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[109] 33 Mtoe

[110] Kalaitzandonakes (2004): identity preservation for non-LMO (Living Modified Organisms) soybeans: 22.5 $/t. Assuming 1 US$ = 0.8 Euro (2004) and 1 t biofuel = 0.76 toe biofuel (average biodiesel, bioethanol).

[111] A mass balance method requires bookkeeping by every actor in the chain. That could be, depending from case to case, 2-8 times the number of the number of actors that have to do bookkeeping in 'book and claim' (which is two). The costs are therefore estimated to be four times as much as those of book and claim.

[112] Costs comparable with those for 'Guarantees of Origin' for renewable electricity, which can be up to € 0.025 per MWh (See E-Track project discussion, page 64). Comparison on the basis that 1 toe of liquid biomass can be used to generate ca. 4.4 MWh electricity.

6.7.1.6. Overall impact of the sustainability criteria

In summary, the recommended approach is as follows:

1. The biofuel sustainability scheme should include:
   - a minimum level of greenhouse gas saving;
   - a ban on the conversion of certain high-carbon-stock land uses;
   - a ban on the conversion of certain high-biodiversity land uses;
   - (in the EU) an extension of the cross-compliance criteria to cover all feedstocks used for biofuel production.
2. Biofuels that do not fulfil one or more of the criteria should not count towards targets; should not be eligible for certain forms of financial support; and should not count towards biofuel obligations.
3. A bonus should be given to biofuels that diversify feedstock sources.
4. Member States should be responsible for verifying compliance. The Directive should facilitate the development of sustainability schemes that will simplify their task. Verification should be through the mass balance method.

The scheme would increase the annual greenhouse gas benefits from the policy by at least 7 Mt CO_{2eq} in 2020. The administrative cost (cost of demonstrating compliance) would be approximately €15m in that year. The cost of compliance itself would be minimal.

Under present-day tariffs and agricultural market rules, it is expected that approximately 8% of the 10% target would be fulfilled through domestic production[113]. Future changes to those rules may lead to a higher share of imports. The sustainability scheme would bear approximately equally on domestic production and imports. Thus, it is not expected to alter this balance. Nor is it expected to alter the balance between the availability and use of petrol-replacing and diesel-replacing biofuels.

6.7.2. Options for promoting the development of second-generation biofuels and other especially desirable biofuels

6.7.2.1. Introduction

This section explores two questions:

(i) How should the set of especially desirable biofuels be defined?

(ii) What bonus should these biofuels receive?

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[113] The impact of a minimum obligation for biofuel use in the EU-27 in 2020 on agricultural markets, op. cit.

6.7.2.2. How should the set of especially desirable biofuels be defined?

(i) Options assessed

In its consultation document, the Commission put forward the idea of a bonus for second-generation biofuels and asked how these should be defined.

In the consultation exercise there was widespread support for the idea of a bonus for certain biofuels – though not necessarily those conventionally defined as second-generation.

The main options proposed by consultees were the following:

A. A bonus for biofuels that are locally produced.

B. A bonus for biofuels that diversify sources of supply

C. A bonus for biofuels that use advanced technologies

D. A bonus for biofuels that ease land-availability constraint

E. A bonus for biofuels made from inedible raw materials

(ii) Assessment of the options

Option A would be discriminatory, and likely to be problematic given the EU's international obligations.. It is not recommended for that reason.

Today, biofuels are made predominantly from agricultural crops. In order to implement **option B** (diversification of sources of supply) it would be necessary to give a bonus for the use of 1) (ligno)-cellulosic materials such as wood and 2) organic waste materials which can be supplied domestically and imported, and will provide further diversification away from both conventional fuels and fuels based on agricultural crops.. To do this would seem an appropriate response to the EU's continuing emphasis on the role of biofuels in improving security of supply by providing for further diversification, complementing the bonus for biofuels with good greenhouse gas performance that the Commission has proposed as an amendment to the Fuel Quality Directive. **This option is therefore recommended**.

Option C, while supported by some consultees, was opposed by many on the grounds that the proper principle to apply is one of technological neutrality. In the light of this point of principle, and the fact that, in addition, no appropriate definition of the relevant 'advanced technologies' has been identified, it does not seem appropriate to use this criterion as the basis for awarding a bonus for certain biofuels. It should be pointed out, however, that advanced technologies will be needed in order to convert ligno-cellulosic material and many types of organic waste into biofuels. Thus, the effect of option B (recommended) will be similar in many respects to that of option C.

Option D is not recommended because in the EU, agriculture faces insufficient demand rather than insufficient supply. Globally, there is significant potential to increase productivity in response to increases in demand.

It should, however, be pointed out that use of cellulosic material from farmed wood would allow more biofuel to be produced per hectare of land than can be produced from agricultural crops; and that wastes do not require land. Thus, the effect of option B (recommended) will be similar in many respects to that of option D.

Option E rests on the hypothesis that it is competition for raw materials, rather than competition for land, that determines the total amount of food and feed that is available. This implies that, in a situation with food shortages but spare land, this spare land would not be shifted into food production. That is illogical. This option is therefore not supported. It should, however, be pointed out that ligno-cellulosic material and organic wastes are not edible. Thus, the effect of option B (recommended) will be similar in many respects to that of option E.

6.7.2.3. What bonus should especially desirable biofuels receive?

(i) Options for assessment

The following options were explored:

A. Biofuels that diversify sources of supply count extra towards national biofuel targets

B. Biofuels that diversify sources of supply are entitled to more financial support

C. Biofuels that diversify sources of supply count extra for biofuel obligations

(ii) Assessment of the options

In assessing **option A** it is important to recall that in the Renewable Energy Roadmap, the Commission proposed the objective of a 10% market share for biofuels and other renewable transport fuels in each Member State in 2020. The spring European Council and the European Parliament have adopted the same objective.

Under option A, some biofuels would count extra towards national targets. For example, if high-performing biofuels counted double, the "10% target" could be fulfilled with a 6% share of ordinary biofuels and a 2% share of high-performing biofuels, giving a total share of only 8%.

This would be incompatible with previous political decisions and this option was therefore not supported.

Under **option B**, where Member States use a support system for biofuels that includes financial support, biofuels with high performance would be entitled to more financial support than those with ordinary performance.

In many cases, this support would qualify as state aid for the purposes of Community law. Under the environmental state aid guidelines[114], Member States may give more support to biofuels that are more costly, including in particular biofuels that are more costly and more effective: , but they are not obliged to do so. It would not be desirable to introduce a different rule here; option B is therefore rejected.

Option C is recommended, since it is not vulnerable to the objections that can be levelled at option B[115]. If support schemes for biofuels are not differentiated in favour of biofuels that are more expensive, the effort to diversify sources of supply will be hampered. Experience in the

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[114] Community guidelines on State aid for environmental protection.

[115] Renewable energy obligations do not normally involve state aid. Where they do involve such aid, the requirement to differentiate the obligation is, of course, subject to Community state aid rules.

electricity sector shows that Member States are more inclined to differentiate their support schemes in favour of more costly technologies where those support schemes take the form of financial support, and less inclined to do so where they take the form of a renewable energy obligation. This underlines the importance of the Directive laying down this requirement in relation to biofuel obligations.

The forthcoming incorporation of binding greenhouse gas reduction targets for fuel suppliers in the Fuel Quality Directive will in any case put an end to state aid for biofuels, at least up to the level of consumption required to fulfil the obligations of that Directive. In this context, there will be a shift towards widespread use of obligations.

Option C was suggested in the consultation document; it did not receive adverse comment.

To implement option C, it is necessary to decide by what margin the favoured biofuels should count extra, relative to others. To identify the size of the bonus that could be expected to draw favoured biofuels into the market, a first approximation can be made by comparing the prices of

conventional fuels (*a*);

first-generation biofuels (*b*); and

second-generation biofuels (*c*).

The size of the bonus needs to be at least

$(c - a)/(b - a$[116].

The review of economic and environmental data for the biofuels progress report[117] estimates these values as follows:

a) price of conventional fuel - €400-580/toe (mid-point: €490/toe);
b) price of first-generation biofuels - €550-850/toe (mid-point: €700/toe);
c) price of second-generation biofuels - €740-1080/toe (mid-point: €910/toe).

The necessary bonus can then be estimated as:

$(910-490)/(700-490) = 2.0$

It is therefore recommended that favoured biofuels should count double, relative to other biofuels, in national biofuel obligations.

6.7.2.4. Conclusion

It is recommended to introduce a requirement for Member States to give double weighting in their biofuel obligations to biofuels that diversify feedstock sources.

As a result, usage of these feedstocks will be higher than would otherwise have been expected. In particular, developers of "second-generation biofuels" will know that if they can develop workable processes, they will be able to find an attractive market for their products.

The results will be improved greenhouse gas savings, reduced environmental impacts of production and increased security of supply benefits.

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[116] A fully precise rule to calculate the bonus would need to be more complex than this; but given the variability of *a*, *b* and *c*, this first order approximation is considered sufficient.

[117] Op. cit.

It is difficult to predict the size of these effects, because this will depend on future scientific and technological progress. In its modelling work, the Commission has taken into account a 30% share of second-generation biofuels in 2020.

The effect of this measure on the relative availability and take-up of petrol-replacing and diesel-replacing biofuels will depend on the rate at which the different second-generation technologies develop (possibilities exist in both parts of the market).

6.7.3. Options for ensuring that fuel standards are compatible with the efficient achievement of the 10% target

6.7.3.1. Introduction

Currently, the major use of biofuels is in low blends with petrol and diesel. Under existing rules, a maximum of 5% by volume of bioethanol can be blended into petrol (Directive 98/70/EC) and a maximum 5% of biodiesel by volume can be blended into diesel (technical standard EN590:2004)[118].

In its proposal to amend Directive 98/70, the Commission proposes increasing the limit on the blending of bioethanol in petrol from 5% to 10%.

The option assessed here is the inclusion in the Directive of a parallel proposal to increase the limit on the blending of biodiesel in diesel from 5% to 10%. This is compared with the option of no change.

In this assessment, the 10% blending of ethanol in petrol is taken as given.

The following questions are assessed:

(i) Is a change to a 10% blend of biodiesel in diesel technically feasible?

(ii) Is a change to a 10% blend of biodiesel in diesel needed?

(iii) What instrument should be used to implement such a change?

6.7.3.2. Is a change to a 10% blend of biodiesel in diesel technically feasible?

Most diesel vehicles on the road are capable of operating without problems on biodiesel blends significantly above B10 (a 10% blend)[119]. In the USA most major engine companies have formally stated that the use of blends up to 20% biodiesel will not void their parts and workmanship warranties and there have been over 45 million miles of successful, problem-free operation with B20 blends in a wide variety of engines, climates, and applications[120,121]. Several car manufacturers are working on the use of high blends of biodiesel in future diesel vehicles[122,123]. It is not known at present how many diesel vehicles

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[118] The requirement in standard EN590 is not legally binding. However, most vehicle manufacturers will not warranty engines if fuel that does not comply with the standard has been used.

[119] See "Twelve years of using 50% RME fuel mixture in heavy trucks and light vehicles", P. Gateau (2006).

[120] http://www.biodiesel.org/resources/fuelfactsheets/standards_and_warranties.shtm

[121] http://www.serconline.org/biodiesel/faq.html

[122] https://www.fleet.ford.com/showroom/environmental_vehicles/biodiesel_vehicles.asp

are not compatible with B10, although the analysis suggests this could be a relative small number (less than 5% of the vehicles operated in the EU at present). Furthermore, by the time the B10 blend will be introduced in the market, even more of the older cars will have been withdrawn from the market further reducing the number of diesel vehicles that are not compatible with B10.

In the light of this analysis it is concluded that a change to a 10% blend of biodiesel in diesel is technically feasible.

6.7.3.3. Is a change to a 10% blend of biodiesel in diesel needed?

Fulfilling the EU target of a 10% share of biofuels (by energy content) will require the use of approximately 33 Mtoe of biofuels in 2020.

Table 34 shows how this target could be fulfilled with and without an increase in the permissible blending of biodiesel in diesel from 5% to 10%.

Table 34 Use of biofuels in 2020

	Biofuel use without B10 (Mtoe)	Biofuel use with B10 (Mtoe)
10% volume blend bioethanol in petrol	10.1	10.1
5% volume blend biodiesel in diesel	8.3	
10% volume blend biodiesel in diesel		16.7
Maximum contribution from low blends of bioethanol and biodiesel	18.4	26.8
10% biofuel target	33.0	33.0
Contribution needed from other biofuel applications	14.6	6.2

As shown in the Table, a 10% volume share of ethanol in petrol would equate to 10.1 Mtoe.

A 5% volume share of biodiesel in diesel – as permitted under the current standard - would equate to 8.3 Mtoe.

Other biofuel applications would then have to contribute at least 14.6 Mtoe.

Such applications include:

> *Use of 100% biodiesel*: this is applied mainly in Germany and to a lesser extent in Austria, mainly in dedicated fleets with modified engines. The car manufacturers no longer provide warranties for 100% engine operation with biodiesel and although some local engine modifications can be undertaken these are limited.
>
> *Use of second generation biofuels that are compatible with existing fuel standards:* There are significant efforts at EU and international level to promote the production and use of second generation biofuels. However, all technologies are still at the development stage and no industrial plant exists. The development work is expected to continue till the period 2010-2014 and the first size commercial plants are expected to become fully operational by 2015-2020. Therefore the contribution of 2nd generation biofuels will be limited. It should be noted that the form of

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[123] http://www.biodiesel.org/pdf_files/OEM%20Statements/2005_OEM_VW%20US%20Biodiesel_Statement_5_16_05.pdf

second-generation biofuel that is currently closest to the market (second-generation ethanol) is chemically identical to first-generation ethanol and does not serve as an alternative to the amendment of fuel standards.

Use of hydrotreated oils: Hydrotreated oils can be blended in high concentrations with diesel fuel (up to at least 30-50%). However, their production is costly[124] and initial plans for large scale production in the EU were recently curtailed. Recent announcements for the construction of large industrial plants in the Far East are positive but they will be based on palm oil which might not meet the EU sustainability criteria. The oil may be consumed locally or supplied to the developing biofuel markets of India and China.

Use of pure plant oil: No car manufacturer will provide warranties for the operation of their engines with pure plant oil. Local engine adaptations can take place in a few EU countries but these can be costly and may result in the cancellation of the original warranty provided by the manufacturer. Therefore the use of pure plant oils will remain limited in the EU.

E85 (85% bioethanol and 15% petrol): The current use of high ethanol blends with petrol such as E85 is only a small share as their use requires significant adaptations in fuel distribution infrastructure (separate fuel distribution is necessary). The cost of constructing new vehicles to operate on E85 is reported to be of the order of 100€ per vehicle[125].

Unlike low blends of ethanol in petrol and of biodiesel in diesel, these applications make a relatively small contribution today. Each faces obstacles in achieving a significantly higher share in future.

In the light of this analysis, the Commission considers that none of these options can be considered with confidence as a reliable alternative to an amendment of the limit on the blending of biodiesel in diesel.

Even if the blending limit for biodiesel in diesel is increased to 10% by volume, these other application will still have to contribute to the 10% target as the volumetric energy content of biodiesel and bioethanol is lower than for diesel and petrol. However, this contribution would have to be significantly lower - at the level of 6.2 Mtoe – and therefore more achievable.

It is therefore concluded that a change to a 10% maximum blend of biodiesel in diesel is necessary and desirable.

6.7.3.4. What instrument should be used to implement such a change?

Two options are assessed:

A. Achieving the change through an amendment to the standard by CEN (the European Committee for Standardisation)

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[124] Investment costs are a factor 3-4 higher based on information in press releases of Neste Oil, compared to those for biodiesel plants.

[125] SEC(2007) 55.

B. Achieving the change through a provision in the present legislative proposal

The Commission has already expressed its desire to see the routine use of B10, mandating CEN in November 2006 to work on a standard that would ensure this. In September 2007 CEN accepted this mandate.

In principle, therefore, the option is available of relying on CEN to make the necessary amendment to the standard, rather than incorporating it in the legislative proposal.

However, there is no guarantee concerning when, or how, CEN will respond to the Commission mandate. The Commission has been informed that CEN may, at this moment, accept only to work on a B7 (7% biodiesel by volume) standard with no indication when it may consider moving on to develop the B10 standard. **Therefore, the option of waiting for the outcome of the mandate given to CEN is rejected.**

Given the importance of this issue for the implementation of the Community's renewable energy targets, it seems inappropriate for the maximum share of biodiesel in diesel (unlike the maximum share of bioethanol in petrol) to remain regulated at the industry level rather than moving into the legislative sphere, with the greater certainty for investors that this can offer.

The recommended approach is therefore **to include a provision in the Directive for a higher biodiesel blend**. In order to facilitate the market introduction of the higher blend the approach recommended is to introduce a 7% biodiesel blend by 31st December 2010 and a 10% blend by 31st December 2014, in all except the smallest filling stations.

This measure is expected to have the effect of removing an obstacle that could otherwise prevent the 10% target for energy content of biofuels in 2020 being achieved; and of ensuring that the balance of petrol-replacing and diesel-replacing fuels used to achieve the target more closely matches the diesel-dominated character of the EU market for road transport fuel.

6.8. State aid implications of the introduction of binding targets for the use of renewable energy

It is important to assess what scope will remain for State aids for renewable energy after the adoption of a renewable energy Directive that sets binding targets for (a) a 20% overall share of renewable energy and (b) a 10% share of renewable energy in transport in 2020.

According to the environmental State aid guidelines, aid should not be allowed for the fulfilment of "mandatory environmental requirements" laid down in Community law.

The binding targets for the share of renewable energy in total energy consumption will not, however, trigger a prohibition of State aid on this basis, because these targets do not constitute mandatory environmental requirements in the sense of the guidelines.

Article 16(6) of the energy taxation Directive (Directive 2003/96/EC) states, *"Should Member States be required by Community law to comply with legally binding obligations to place on their markets a minimum proportion of the products referred to in paragraph 1 [bioenergy products], paragraphs 1 to 5 [authorising tax exemptions] shall cease to apply as from the date when such obligations become binding on the Member States."*

Because the renewable energy used in transport consists almost exclusively of biofuels, the binding targets for renewable energy in transport in the Directive will trigger this prohibition in 2020. Despite this, it will continue to be possible even in 2020 for Member States to give:

- aid for biofuels that does not take the form of tax exemptions;

- tax exemptions for the use of biofuels outside the transport sector;

- tax exemptions for the use of biomass in heating or electricity (because the binding target for the share of renewable energy in total energy consumption can be fulfilled with many energy sources, only some of which fall – as bioenergy – within the list of products in article 16(1): the targets do not therefore impose a legally binding obligation to place a minimum proportion of these bioenergy products on the market.)

- place 'biofuel' or 'renewable energy' obligations on fuel suppliers,

The requirements in article 7a of the Commission's proposal to revise the fuel quality Directive (Directive 98/70/EC) will constitute mandatory environmental requirements in the sense of the environmental State aid guidelines. They will therefore trigger a prohibition on State aid for the means by which fuel suppliers can meet the obligation – including biofuels and other alternative fuels (except those that do not reduce greenhouse gas emissions) – up to the point at which the obligation laid down by the Directive has been complied with. . The option of placing renewable energy obligations on fuel suppliers will, however, remain available. Biofuel obligations are already in widespread use among Member States, and appear to be effective; this change in the range of permissible types of support scheme will not therefore prevent the 10% biofuel target being achieved.

7. IMPACT DIFFERENT OPTIONS TO IMPLEMENT THE GHG AND RES TARGET -PREFERRED OPTIONS AND CONCLUSIONS

The energy and climate change package can be implemented in different ways. The GHG reduction commitments for the EU ETS, sectors not covered by the EU ETS and the RES targets could be allocated ex ante on a cost efficient way. But this tends to imply disproportionate costs for the Member States with a GDP per capita below EU average.

GHG reduction commitments in the sectors not covered by the EU ETS could be allocated in such a way that Member States with a higher capacity to pay get higher efforts awarded. Furthermore there is the option to distribute the auctioning rights differently between Member States. Given that redistribution of RES targets might lead to high costs, trade in RES could be allowed. Finally investments in JI/CDM impacts on the overall costs of the package.

In Table 35 an example is given of reduction targets by 2020 compared to 2005 levels for the sectors not covered by the EU ETS per Member State, of RES targets per Member State by 2020 and of auctioning with a certain distribution of auctioning rights between the Member States. Table 36 gives an overview what the EU wide implications are of such targets with and without RES trade through GOs and with or without reductions outside the EU via JI/CDM. The JI/CDM case assumes that carbon prices are reduced in the EU to the level of 30€ per ton $CO_{2\text{-eq.}}$ Member States that can achieve their Non-ETS targets at a price lower than this 30€ do so with a carbon price below 30 €.

Table 35: Example targets 2020 with distribution in the RES target and the GHG reduction targets for the sectors not covered by the EU ETS

Targets 2020	Reduction target in sectors not covered by the EU ETS compared to 2005	Share Renewables in the final energy demand by 2020	Amount of auctioning rights received by Member States on top of the 90% distributed according to proportional 2005 EU ETS emissions
AT	-16.0%	34%	0%
BE	-15.0%	13%	10%
BG	20.0%	16%	53%
CY	-5.0%	13%	20%
CZ	9.0%	13%	31%
DK	-20.0%	30%	0%
EE	11.0%	25%	42%
FI	-16.0%	38%	0%
FR	-14.0%	23%	0%
DE	-14.0%	18%	0%
EL	-4.0%	18%	17%
HU	10.0%	13%	28%
IE	-20.0%	16%	0%
IT	-13.0%	17%	2%
LV	17.0%	42%	56%
LT	15.0%	23%	46%
LU	-20.0%	11%	10%
MT	5.0%	10%	23%
NL	-16.0%	14%	0%
PL	14.0%	15%	39%
PT	1.0%	31%	16%
RO	19.0%	24%	53%
SK	13.0%	14%	41%
SI	4.0%	25%	20%
ES	-10.0%	20%	13%
SE	-17.0%	49%	10%
UK	-16.0%	15%	0%

The cost efficient allocation would result in a cost of implementing the 20% RES and 20% GHG target of 91 billion € in the EU. Implementing distributed GDP modified RES targets and GHG targets for the sectors not covered by the EU ETS without access to RES trade or JI/CDM would increase the costs to 103 Bn € by 2020 compared to the baseline. Overall increased GHG mitigation costs and RES costs would represent 0,66% of GDP while in the cost efficient case this is only 0,58%. Introducing RES trading and achieving the RES target again cost efficiently would reduce the costs in the overall energy system by up to 8[126] Bn € by 2020. Introducing reductions outside the EU through JI/CDM would reduce costs with a further 25 billion € if the carbon price would reach 30 €/ton CO2-eq.

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[126] PRIMES scenarios are assuming full trade, which is an overestimation with respect to the proposed regime.

Table 36 EU wide Impact distribution of RES target and the GHG reduction commitments for the sectors not covered by the EU ETS in 2020[127]

	Cost efficient case	Targets non EU ETS modulated according to GDP/capita		
		YES		
		RES Trade?		
		NO	YES	YES
		Access to JI/CDM?		
		NO	NO	YES Carbon price = 30 €
GHG reduction compared to 1990	-20%	-20%	-20%	-14%
GHG reduction compared to 2005	-14.4%	-14.4%	-14.4%	-9.3%
RES share by 2020	20%	20%	20%	20%
Carbon price in the EU-ETS (€/ton CO2-eq.)	39	47	43	30
Average Carbon price Non EU-ETS	39	37	37	22
RES incentive (€/MWh)	45	51	44,5	49
Increases cost Energy system and mitigation cost non-CO2 (bn €) including cost to buy credits from CDM	91	103	95	70
Increases cost Energy system and mitigation cost non-CO2 (% GDP)	0.58%	0.66%	0.61%	0.45%

Source: Primes/Gains

At Member State level, the distribution as proposed in Table 35 has considerable impacts on the overall costs experienced within the Member States compared to the cost if a cost efficient allocation of all targets would be applied (see Table 37). For Member States with a GDP per capita below the EU average costs would be considerably reduced in this example. In the cost efficient case all these Member States, with the exception of Malta and Cyprus would experience a higher cost relative to GDP than the EU average. This picture changes completely after distribution of the different commitments. All Member States with a GDP per capita below the EU average would now experience overall cost, including trade effects, auctioning rights distribution and cost for acquiring CDM, that are lower than the EU average, with the exception of Portugal, Slovenia and Greece.

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[127] In the case of access to JI/CDM, carbon prices can be lower in the non-ETS than €30/t CO2 for those Member States that can achieve their non-ETS targets at a lower price. Therefore the average carbon price in the Non EU ETS is below 30€ in the scenario with access to JI/CDM, i.e. 22 €.

Table 37: Impact at Member State level of distribution of RES target, GHG reduction commitments for the sectors not covered by the EU ETS and rights to auction allowances[128]

	Cost efficient achievement of: -the RES target - GHG target	Cost efficient achievement of : - the RES target - the EU ETS target	Cost efficient achievement of: - the RES target - the EU ETS target	Cost efficient achievement of: - the RES target - the EU ETS target	Cost efficient achievement of: - the RES target - the EU ETS target
Cost as % of GDP 2020		**But:** 1. redistribution of the targets in the Non- EU ETS according to GDP/cap	**But:** 1. redistribution of the targets in the Non- EU ETS according to GDP/cap 2. redistribution of the auctioning rights	**But:** 1. redistribution of the targets in the Non- EU ETS according to GDP/cap 2. redistribution of the auctioning rights 3. JI/CDM with carbon price of 30 €	**But:** 1. redistribution of the targets in the Non- EU ETS according to GDP/cap 2. redistribution of the auctioning rights 3. JI/CDM with carbon price of 30 € 4. redistribution of the RES targets together with full RES trade
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
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

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[128] Targets in the Non-ETS are marginally modified compared to the approach in **Figure 2** for Slovenia, Latvia and Greece. Projected costs for this change are interpolations of results from PRIMES/GAINS.

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

Source: Primes/Gains

In Table 38 an example is given of the macro-economic impacts assessed with the GEM-E3 model of a cost effective allocation of GHG reduction targets to Member States with free allocation of allowances, a cost effective allocation but with full auctioning in the EU ETS (see also Table 8) and a redistribution of the auctioning rights (see also Table 13)and reduction commitments (see also Table 7) in the sectors not covered by the EU ETS across Member States.

The combination of auctioning and the redistribution of both auctioning rights and targets for the sectors not covered by the EU ETS has a positive effect on the overall economic cost compared to a cost effective case with no auctioning or redistribution. Member States with a GDP per capita below EU average benefit substantially through an improvement in their private consumption or GDP impact. Employment benefits are overall positive, certainly in the EU15 Member States. Impacts on GDP and private consumption for the richer Member States is limited and mixed.

Improvements in private consumption are particularly large. This is due to the fact that auctioning revenues are recycled through transfers to households. If revenues would be recycled through other manners, for instance labour taxes or taxes on profits, then the positive effects on labour or GDP would most probably be more outspoken.

Table 38: Macro economic Impact at Member State level of auctioning in the EU ETS and of distribution of auctioning rights and GHG reduction commitments for the sectors not covered by the EU ETS

	Cost efficient achievement of: -the RES target - GHG target			Cost efficient achievement of: -the RES target - GHG target			Cost efficient achievement of: -the RES target - GHG target in the EU ETS		
	With free allocation in EU ETS and no revenue generation in the sectors not covered by the EU ETS			With auctioning in the EU ETS and no revenue generation in the sectors not covered by the EU ETS			With auctioning in the EU ETS and no revenue generation in the sectors not covered by the EU ETS With redistribution auctioning rights in the EU ETS With redistribution GHG reduction targets in the sectors not covered by the EU ETS		
	Change GDP	Change Private Consumption	Change employment	Change GDP	Change Private Consumption	Change employment	Change GDP	Change Private Consumption	Change employment
	Compared to baseline								
EU	-0.54%	-0.11%	-0.41%	-0.35%	0.19%	-0.04%	-0.45%	0.13%	-0.11%
AT	-0.4%	-0.1%	-0.3%	0.0%	0.3%	0.4%	-0.1%	0.0%	0.4%
BE	-0.5%	-0.1%	-0.3%	-0.4%	0.2%	0.0%	-0.7%	-0.3%	-0.1%
BG	-2.5%	-1.1%	-0.5%	-2.4%	1.3%	-0.5%	-0.9%	8.1%	-0.6%
CZ	-1.7%	-2.1%	-0.7%	-1.7%	0.2%	-0.7%	-1.6%	7.1%	-1.5%
DK	-0.4%	-0.3%	-0.2%	-0.1%	-0.1%	0.4%	-0.5%	-0.6%	0.3%
EE	-2.2%	-3.4%	-0.9%	-2.3%	-0.4%	-1.1%	-2.6%	8.8%	-2.2%
FI	-0.6%	-0.3%	-0.3%	-0.6%	0.4%	-0.3%	-0.8%	0.0%	-0.3%
FR	-0.5%	0.0%	-0.3%	-0.3%	0.1%	0.0%	-0.8%	-0.7%	-0.2%
DE	-0.5%	-0.1%	-0.3%	-0.3%	0.1%	-0.1%	-0.4%	0.0%	-0.1%
EL	-0.9%	-0.6%	-0.6%	-0.8%	-0.2%	-0.3%	-0.6%	1.2%	-0.4%
HU	-1.7%	-1.4%	-0.8%	-1.5%	-0.8%	-0.4%	-0.8%	0.7%	-0.3%
IE	-0.3%	-0.4%	-0.5%	0.2%	-0.1%	1.3%	-0.2%	-1.3%	0.9%
IT	-0.4%	0.3%	-0.2%	-0.1%	0.5%	0.3%	-0.1%	0.4%	0.3%
LV	-1.0%	-1.3%	-0.3%	-0.9%	-0.8%	-0.2%	-0.4%	0.4%	-0.2%
LT	-0.6%	0.1%	-0.5%	-0.6%	0.9%	-0.5%	-0.3%	1.0%	-0.3%
NL	-0.6%	0.3%	-0.2%	-0.4%	0.5%	0.1%	-0.5%	0.2%	0.1%
PL	-1.6%	-2.0%	-0.9%	-1.5%	-0.8%	-0.7%	-1.0%	2.5%	-0.8%
PT	-0.4%	0.1%	-0.3%	-0.3%	0.4%	-0.1%	-0.3%	0.6%	-0.1%
RO	-2.6%	-1.9%	-0.8%	-2.4%	1.6%	-0.8%	-1.6%	9.1%	-1.2%
SK	-1.7%	-0.2%	-0.8%	-1.7%	1.3%	-0.8%	-1.0%	3.5%	-0.7%
SI	-0.7%	-0.6%	-0.5%	-0.6%	-0.4%	-0.5%	-0.9%	0.3%	-0.8%
ES	-0.7%	0.0%	-0.5%	-0.1%	0.7%	0.8%	-0.1%	0.5%	0.9%
SE	-0.3%	0.0%	-0.2%	-0.2%	0.1%	-0.1%	-0.6%	-0.5%	-0.2%
UK	-0.4%	-0.2%	-0.3%	-0.3%	-0.1%	-0.1%	-0.4%	-0.2%	-0.1%

Source: GEM-E3 Europe

8. ANNEXES

8.1. Annex 1

The PRIMES baseline, update 2007

The Baseline 2007 gives an update of the previous trend scenarios, such as the "Trends to 2030" published in 2003 and its 2005 update. The new Baseline takes into account the high energy import price environment of recent years, sustained economic growth and new policies and measures implemented in the Member States. The results were derived with the PRIMES model by a consortium led by the National Technical University of Athens, supported by some more specialised models. Energy experts from Member States commented on the draft Baseline for their countries. Comments have been taken into account for the subsequent runs of the model while preserving a harmonised approach as regards assumptions on e.g. energy import prices, CO2 prices, GDP growth rates, etc and making sure that import and export projections for intra-community trade are consistent.

The Baseline for the EU and each of its Member States simulates current trends and policies as implemented in the Member States by the end of 2006. While informing about the development of policy relevant indicators, such as the renewables shares, the Baseline does not assume that targets, as set out in Directives, will be necessarily met. The numerical values for these indicators are outcomes of the modelling; they reflect implemented policies rather than targets. This applies also for CO2 emissions that are not constrained by Kyoto targets in the Baseline.

The 2007 update of the energy Baseline starts from projections on economic growth (2.2% on average up to 2030) in line with DG ECFIN short and long term expectations as well as slightly increasing population up to 2020 with no further increase thereafter.

	Annual GDP Growth rate	
	2000 - 2010	2010 - 2020
EU	2.2%	2.4%
AT	2.0%	1.9%
BE	1.9%	2.0%
BG	5.2%	5.8%
CY	3.4%	3.6%
CZ	4.1%	3.6%
DK	1.9%	1.8%
EE	8.1%	3.8%
FI	2.8%	1.9%
FR	1.9%	2.4%
DE	1.3%	1.7%
EL	4.0%	2.8%
HU	3.8%	3.5%
IE	5.0%	3.5%
IT	1.2%	1.9%
LV	8.1%	5.4%
LT	7.1%	4.7%
LU	3.8%	3.4%
MT	1.4%	3.7%
NL	2.0%	1.9%

PL	3.7%	4.6%
PT	1.3%	2.7%
RO	5.7%	5.8%
SK	5.1%	4.5%
SI	3.7%	2.6%
ES	3.3%	2.9%
SE	2.8%	2.3%
UK	2.5%	2.3%

Energy import prices have been derived from a world energy model (POLES) taking into account market power of e.g. OPEC. The energy projections are based on a high oil price environment with oil prices of 55 $/bbl in 2005 rising to 63 $/bbl in 2030 (prices are in 2005 money; in nominal terms this could be over 100 $/bbl in 2030 if it is assumed that the inflation target of the ECB of 2% pa would be achieved). The baseline price assumptions for the EU are the result of world energy modelling that derives price trajectories for oil, gas and coal under a conventional wisdom view of the development of the world energy system. Fossil fuel prices in the Baseline develop as follows:

Prices for EU imports of fossil fuels in $ / boe in money of 2005

	2005	2010	2015	2020	2025	2030
Oil	54.5	54.5	57.9	61.1	62.3	62.8
Gas	34.6	41.5	43.4	46.0	47.2	47.6
Coal	14.8	13.7	14.3	14.7	14.8	14.9

Tax rates are kept constant in real terms as they were in 2006 unless there is better knowledge. This concerns transition periods for some Member States to adapt to EU minimum tax rates from current lower levels, with the EU minimum rates being applied at the end of the respective transition periods.

The 2007 Baseline includes policies and measures implemented in the Member States up to the end of 2006. Certain policies that are part of the energy and climate change package are not yet taken into account because they are not yet implemented through approved legislation. This is for instance the case for the CO_2 and cars policy, the Carbon Capture and Storage initiative that should lead to 12 demonstration plants by 2015 and the full implementation of the Energy Efficiency Action Plan. It does include assumptions on the completion of the internal energy market by 2010 taking into account derogations for electricity and gas market opening, assumptions on the implementation of the building, CHP and labelling Directives, for renewables the implementation of measures under the existing electricity and biofuels Directives and the nuclear phase-out as agreed in certain Member States. Finally the continuation of the EU ETS is assumed over the projection period without extension to new sectors The CO2 prices in the ETS sectors increase from 20 €(2005)/t CO2 to 22 €/t CO2 in 2020 and 24 €/t CO2 reflecting current levels and preserving the baseline approach of assuming a continuation of current policies – but taking into account that CDM/JI credits may become more expensive over time.

This Baseline has been used as a starting point for both GHG and RES related scenario work undertaken in DG ENV and DG TREN.

Primary energy demand in the Baseline continues growing (+9% from 2005 to 2020) due to ongoing economic growth (2.4% pa), however allowing for significant energy intensity improvements (1.8% pa). This development is due to structural change towards less energy intensive services and industries as well as energy efficiency improvements in power generation and final demand supported by a shift to fuels supporting higher efficiencies (e.g. natural gas, wind). The structure of energy demand changes towards more use of renewables and natural gas; RES increase most followed by natural gas; solid fuels and oil increase somewhat but lose in terms of market share; nuclear declines following the phase-out decisions in some Member States.

The renewables share in final energy demand increases 4 percentage points to reach 12.5% in 2020, suggesting that meeting the 20% RES target for 2020 will require strong additional policies on RES, which would be supported by policies on energy efficiency and CO2, reducing energy demand.

The energy economy becomes increasingly reliant on energy imports – with import dependency reaching 67% in 2030, up from slightly more than 50% at present.

Energy related CO2 emissions decrease almost 2% below the 1990 level in 2010 reflecting the effects of emission trading and other energy and climate measures as well as the accession of new Member States that underwent deep economic restructuring and declining emission in the 1990s. In the longer term, CO2 emissions rise above the 1990 level by 5% in 2020. CO2 emission growth is contained by energy intensity improvements and the growing contribution of renewables. Other GHG are derived with the GAINS model using PRIMES baseline (or other scenario) results as input for the energy related parts (in addition to those coming e.g. from agricultural activities).

8.2. Annex 2

EU ETS SECTORS IN PRIMES AND ACTUAL REPORTED EMISSIONS IN THE EU ETS

The following sectors represented in PRIMES are assumed to be included in the EU ETS:

- Thermal power plants and District heating units

- CHP plants

- Refinery Boilers and the Rest of the Energy Supply System

- All other boilers in industry

- All other energy emissions and CO2 process emissions from Iron and steel, Non Ferrous Metals, Chemicals, Non Metallic Minerals and Pulp and Paper

- Aviation (intr-EU and outbound aviation[129]).

The emissions in the EU ETS sectors (excluding aviation) as defined in PRIMES/GAINS are not equal to those actually reported under the EU ETS. Emissions for the EU ETS sectors are larger in PRIMES/GAINS because they include for instance emissions of small installations not covered by the EU ETS.

For the EU27 Member States total GHG emissions in the EU ETS in 2005 are estimated to be at 2208 Million ton $CO_{2\text{-eq.}}$, including an approximation of the emissions in 2005 of the installations that where not covered in the ETS in the first trading period but are covered in the second trading period. The EU ETS sectors (excl. aviation) defined in PRIMES/GAINS emitted 2382 Million tons of CO2 emissions in 2005. Emission from the EU ETS as reported in 2005 thus cover 93% of the emission as represented under PRIMES/GAINS for the EU ETS sectors (excl. aviation). This means that around 7% of emission in the EU ETS sector under PRIMES/GAINS actually belong to the Non-ETS sector.

To determine correctly the effort by the EU ETS and the Non-ETS sectors, a correction was made on the modelled emissions in the EU-ETS sector to come closer to the actual coverage under the EU-ETS. This implies that part of the emissions from the EU ETS sector are transferred to the non-EU ETS sector.

It was assumed that the sectors covering thermal power plants and district heating in PRIMES are fully included in the EU ETS and that the remaining sectors have a share of small installations that are transferred to the non-ETS.

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[129] Inbound aviation should be addressed by measures in third countries: the EU ETS will only cover these impacts where this is not the case.

8.3. Annex 3

Comparative price level indices for 2005 of consumer good and gross fixed capital formation (EU27=100)

	Actual individual consumption	Gross fixed capital formation	Construction	Machinery and equipment
EU-27	100	100	100	100
AT	103	107	117	99
BE	105	99	104	99
BG	36	53	33	86
CY	88	80	69	104
CZ	54	71	56	94
DK	143	126	141	114
EE	57	78	68	92
FI	124	105	108	103
FR	106	109	111	105
DE	106	105	111	101
EL	85	85	74	108
HU	58	78	70	94
IE	124	127	137	108
IT	106	91	85	98
LV	49	69	58	87
LT	48	74	67	85
LU	114	100	102	95
MT	70	72	59	100
NL	105	113	129	98
PL	56	65	50	94
PT	86	78	63	106
RO	49	60	41	93
SK	50	73	56	98
SI	74	70	57	92
ES	90	96	95	98
SE	120	126	164	99
UK	111	115	130	98

8.4. Annex 4

THE CALCULATION OF THE RENEWABLE ENERGY SHARE OF FINAL ENERGY CONSUMPTION

Final energy consumption represents the energy commodities delivered to the final consumers (manufacturing industry, transport, households, services, agriculture, forestry and fisheries) for energy purposes (heat and power). It is lower than the Gross Inland Consumption essentially because of losses in producing derived energy commodities (transformation losses essentially in heat and power stations), transmission and distribution losses, consumption of the energy industry and non-energy use of fossil fuels.

The Directive on electricity from renewable energy defined the Member State objectives as the national consumption of renewable energy sources RES-E divided by the gross national electricity consumption (which differs from the consumption of final consumers by the transmission and distribution losses and the electricity consumption of the energy sector).

The biofuels Directive defined the Member State objectives as the proportion of biofuels placed on the diesel and gasoline market, therefore at consumer level.

For heat, no definition of a specific objective is yet made in EU legislation. However, a definition at the level of the gross final consumption would be heat produced from renewable sources divided by total heat needed for meeting final consumption heat needs (i.e including distribution and transmission losses and the consumption of the energy sector for producing heat[130]).

On the basis of an energy balance sheet, total heat delivered to final consumers represent all energy commodities (except of electricity) delivered to final consumers for non transport purposes. The renewable part of total heat will include all biomass, solar thermal and geothermal energy used in final consumption plus the renewable origin part of district heating. In 2004 renewable energy constituted 19% of the total input to heating plants and 13% of the total CHP input[131].

A global target on renewable energy (***share of renewables to gross final energy consumption***) could be set at final energy consumption level**,** as follows:

$$\frac{\textit{Gross production of renewable electricity + biofuels for transport + heat produced from RE}}{\textit{Gross Final Energy Consumption}^{132}}$$

This approach would link the three sectoral targets:

-Share of renewable electricity to gross electricity consumption:

This is the ratio of electricity generation of renewable origin (hydro excluding production of pumping units, wind, solar and geothermal energy), to gross electricity consumption (gross

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[130] i.e. excluding the energy consumption of refineries, coal mines or patent fuel plants

[131] Source Eurostat energy balance and CHP Directive 2004/8/EC data submission.

[132] The Gross Final Energy Consumption is the final energy consumption including consumption of the energy branch for producing electricity and heat and transmission/distribution losses for electricity and heat production.

generation from all energy sources plus imports minus exports of electricity).

-Share of biofuels to the final consumption of diesel and gasoline for transport:

This is the ratio of biogasoline, biodiesel and other liquid biofuels, to the final consumption of diesel and gasoline for transport.

-Share of renewables used for heating to the final consumption for heating:

This is the ratio of final consumption of renewables (biomass, solar and geothermal energy) for heat production in industry and other sectors (households, services, agriculture, etc.), together with final consumption of district heat (from heating and CHP plants) of renewable origin, to the total consumption for heat production. The total consumption for heat production is the final consumption of the industry, households, services, etc. of all commodities except electricity plus the consumption of the energy sector for producing heat

It should be noted that the energy balances prepared by Eurostat (based on the physical energy content method) allow the direct calculation of the renewable energy targets expressed in both Gross Inland Consumption and gross final energy consumption as well as the three sectoral indicators. In addition, the Regulation on energy statistics (to be adopted by co-decision later this year) will make obligatory the supply of these statistics, which will strengthen the quality of all variables involved in the calculation of all the above indicators.

Comparing the primary and final approaches it should be noted that the *renewables share based on Final Energy consumption* presents certain advantages, namely:

- all forms of electricity generation (renewable origin or nuclear / fossil fuel origin) are treated alike. Indeed, every kWh is counted on an equal footing close to the level of final energy consumption

- final energy consumption and thus relevant indicators are independent of non-energy use of petroleum products (e.g. asphalt), affecting the renewables share based on Gross Inland Consumption

- the electricity and the biofuels accounting in final energy are the ones defined in Directives 2001/77/EC and 2003/30/EC, ensuring greater consistency and continuity between the existing legal texts established and the new legal proposal on renewable energy sources.

Finally, in order to avoid distortions due to hydrology variations, the contribution of hydropower to renewables will be normalised. The normalised hydro production will be calculated on the basis of the hydro installed capacity (excluding capacity for pumping) and the average load factor over the last 15 years.

8.5. Annex 5

The different models used to analyse the 20% RES target

The PRIMES modelling undertaken in the framework of deriving GHG targets for 2020 also achieves an EU RES share of 20% in 2020 (referred as PRIMES 20-20). This modelling starts from the PRIMES baseline and examines the simultaneous achievement of GHG and RES targets through disincentives for producing carbon and incentives for using RES (introduction of carbon and renewables values). The reactions of the energy system to both the carbon and renewable values go also via increased energy costs and lead to higher energy prices. With these higher energy prices, together with substitution processes towards cleaner and often more efficient energy sources, energy demand decreases. Primary energy consumption in the PRIMES 20-20 modelling declines 10% in 2020 compared with baseline.

The PRIMES 20-20 modelling starts from the new PRIMES baseline, which shows developments under current trends and policies.

The PRIMES high energy efficiency case models the vigorous implementation of existing Directives on e.g. building performance, CHP, end-use energy efficiency and energy services, eco-design in the Member States as well as further efficiency policies along the lines of the Energy Efficiency Action Plan. These policies and measures are expected to lead to a considerable reduction of total energy demand. EU-27 primary energy demand would be 15% lower in 2020 than under current trends and policies (PRIMES baseline with policies implemented up to the end of 2006) and 17% lower in final energy. While the efficiency case does not fully achieve the political objective of 20% better energy efficiency in 2020, it shows the results of achieving the lion's share of this with agreed policies that still need to be implemented and those currently under preparation.

The PRIMES high energy efficiency case considers the energy efficiency measures (see above) that enable individual energy consumers to make more rational choices (providing e.g. information, labelling, standards removing cost-inefficient and energy-inefficient items), which leads to lower energy consumption. PRIMES 20-20 modelling builds on reactions of consumers to cost and price increases. With inelastic energy demand (limited reaction of consumers to price increases) and the absence of policies to remedy this situation (e.g. agreed energy efficiency measures to be implemented and in the pipeline), there is a more limited reaction of consumers leading to less energy intensity improvements. Specific energy efficiency policies are expected to be more effective than pure price effects.

The use of carbon values and RES incentives in the PRIMES 20-20 modelling reflects the main objective of CO2 reduction through market based instruments both in the current ETS sectors and also in the other sectors. High carbon values encourage RES, nuclear and also fuel switching towards lower carbon fuels such as natural gas. The RES modelling has CO2 reduction as a welcome consequence but does not target such reductions and therefore needs no carbon values for the whole energy sector. Nevertheless, both the PRIMES baseline and the efficiency case have a carbon price of 22 € / t CO2 in 2020 for the ETS sectors.

For a more detailed description of the PRIMES Baseline 2007, see Annexes

Annex 1.

In addition a PRIMES high renewables and energy efficiency scenario has been used for broadening the analytical basis for examining RES related issues. This case starts from the assumption that the implementation of EU energy policies underway in the field of energy efficiency will result in lower energy consumption and by this support the achievement of targets on the share of renewables. Better energy efficiency will be achieved through the implementation of agreed but not yet implemented Directives, such as the Directives on eco-design as well as end-use energy efficiency and energy services. Moreover, this scenario includes the policies envisaged in the Energy Efficiency Action Plan adopted in October 2006. As a result of these energy efficiency policies and the renewables policies in this scenario energy consumption would be 17% lower in 2020 compared with the baseline. This scenario brings the EU a long way towards the objective endorsed by the Brussels European Council "of saving 20% of the EU's energy consumption compared to projections for 2020".

The RES share in gross final energy demand reaches 20% for EU-27 in 2020 in the high RES and efficiency case while the biofuels share amounts to 10%. Primary energy consumption in this scenario would decrease thanks to vigorous energy efficiency policies. In 2020, energy demand would be 10% lower than it was in 2005. The reduction in energy demand translates into corresponding improvements in energy intensity as assumption on GDP remain unchanged from baseline in this high efficiency and renewables scenario[133]. Energy intensity improves by 3.0% pa up to 2020 as a result of efficiency policies, structural change in the economy and the greater use of more efficient RES, such as wind power.

Import dependency would be reduced to 58% in 2030 in this scenario, down from 67% in the baseline. CO2 emissions decrease thanks to RES penetration and energy efficiency. They stay 3% below the 1990 level in 2010 and fall 22% in 2020 compared with 1990. CO2 benefits continue in the long term with emissions decreasing 30% below 1990 in 2030.

These developments are triggered by policies that have a cost. In the model, this is simulated through the cost effects of energy system restructuring stemming from policies to reduce energy consumption and to achieve a 20% share of renewables in 2020. The shadow prices associated with RES and energy efficiency targets (renewables and efficiency values) are determined by using the model and reflect the marginal costs incurred for reaching the policy goals. This scenario does not include a constraint on CO2 emissions, but leads nevertheless to important CO2 reduction as a result of energy efficiency and RES policies. The CO2 price in the current ETS sectors remains the same as in the baseline: e.g. 22 €/CO2 in 2020 and there is no CO2 price for the non-ETS sectors. The efficiency value in 2020 amounts to 300 €/toe final demand, while the RES value reaches 35.3 €/MWh[134]. These rather high shadow prices for achieving better energy efficiency and greater use of renewables trigger a restructuring of the energy system. This leads to an increase of the overall energy system cost, including all direct, indirect and transaction costs, by 3.6% in 2020 when compared to an unsustainable energy baseline[135]. Such an ambitious policy scenario implies a higher ratio of energy costs

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[133] the high RES and efficiency scenario

[134] Contrary to the efficiency value, the RES value is largely internalised in the costs borne by energy consumers e.g. through higher electricity prices brought about by changes in investment patterns towards more RES, which are passed on to consumers via higher electricity prices

[135] Focusing only on costs for fuels and energy equipment would even lead to a reduction in system costs of 13.3% below baseline in 2020, but would neglect costs related to e.g. action on better insulation as well as on information and overcoming other barriers to better energy efficiency and RES penetration.

(in a wide sense including non-cash costs) to GDP, which increases from 9.87% in 2005 to reach 10.01% in 2020 compared with 9.66% under baseline conditions in 2020.

8.6. Annex 6

Sharing the 20% Renewables energy target among member states

Two options were compared: sharing on the basis of Member States' national resource potential to produce renewable energy and sharing on the basis of a formula that applies a flat rate increase in the share of renewable energy (measured in percentage points) weighted by GDP taking early action into account and with a cap on maximum RES energy mix.

- - Targets based on analysis of national resource potential

One of the characteristics of renewable energy is that although abundant in the whole European territory, the potential of each specific technology and the costs of these technologies are not equally distributed across Member States. This is the main reason why different targets are needed for each Member State.

The PRIMES model was used to develop the potential-based scenario based on a cost efficient implementation of both the GHG and RES targets

It can be seen that national targets differ substantially between Member States, as do the percentage point increases required (between 6 and 17%). This is because resource potential differs. For example, the marginal costs of biomass in countries with major forest industries is low compared with other Member States; solar energy is cheaper in southern Europe than in the North; wind energy potential is greater near the Atlantic and in certain parts of the Mediterranean.

However, the differences between the additional efforts required from Member States (the percentage point increases) are not as large as might intuitively be expected. This is because weaker potential in one technology is often compensated by stronger potential in another.

Member States with high population density tend to receive a target lower than the average, as do islands. Member States with abundant, cheap potential receive targets higher than the average.

Targets based on a flat-rate increase plus GDP

Under this option, national targets were established in the following way:

In a first step, a forecast of EU gross final energy consumption in 2020 is established (PRIMES model "cost-efficient" reference case) – at 1270.6 Mtoe. The renewables’ target for the EU is 20% of this figure. According to the forecast – which assumes significant improvements of energy efficiency – this amounts to 254.1 Mtoe of renewable energy. (Column 2 of the table below).

By subtracting from the target of 254.1 Mtoe the renewable energy production of 2005 adjusted for one third of the early action in those Member States that have increased their renewables share by at least 2 percentage points between 2001 and 2005 (101.9 Mtoe), the required additional effort is determined. That is 254.1 – 101.9 = 152.2 Mtoe.

This additional effort would be shared as follows:

Half of this effort (5.5%[136] or 76.1 Mtoe) is apportioned to Member States so that a fixed percentage – common to all – is added to their renewable energy share in 2005 (Column 3 of the table).

It follows that if all Member States increase their current share of renewable energy by 5.5 percentage points, the EU as a whole will be 76.1 Mtoe short of meeting its 20% target – on the assumption that the final energy demand forecast for 2020 materialises.

These residual 76.1 Mtoe – i.e. the remaining half of the effort – are divided by the EU population to determine an 'effort per citizen'. This 'effort per citizen' is then multiplied by a GDP per Head index. As a result, a citizen of the richest country in terms of GDP per Head (Luxembourg) has to contribute an amount of RES production 23 times as large as that of a citizen of the poorest Member State (Bulgaria). (Column 4 of the table).

The effort per citizen, adjusted by the GDP per Head index, is then multiplied by the population of the respective country to determine the aggregate residual effort per Member State. (Column 5 of the table).

The residual effort is then added to the amount of production already established for the Member States (RES share in 2005 plus flat rate) to determine the final amount of RES production in Mtoe (Column 6 of the table) and as a percentage of final energy consumption in 2020 (Column 7 of the table).

	1 RES share in 2005 *	2 Forecast 2020 gross final energy consumption (reference scenario)	3 RES share after flat rate increase of 5.5%	4 Residual effort per citizen adj. by GDP/Head index	5 Residual effort per MS	6 Total RES needed in 2020	7 Targets: Total RES
	%	MTOE	%	TOE	MTOE	MTOE	%
Austria	23,3	29,5	28,8	0,21	1,69	10,18	34,5
Belgium	2,2	37,4	7,7	0,20	2,08	4,95	13,2
Bulgaria	9,4	12,3	14,9	0,02	0,15	1,98	16,1
Cyprus	2,9	1,9	8,4	0,12	0,09	0,26	13,2
Czech Rep.	5,0	30,2	10,4	0,07	0,69	3,84	12,7
Denmark	15,4	15,6	20,9	0,27	1,44	4,70	30,1
Estonia	17,1	3,7	22,6	0,06	0,08	0,91	24,7
Finland	28,5	25,7	34,0	0,21	1,09	9,82	38,2
France	10,3	164,6	15,8	0,19	11,84	37,79	23,0
Germany	5,8	220,0	11,3	0,19	15,53	40,33	18,3
Greece	6,9	24,4	12,4	0,12	1,37	4,39	18,0
Hungary	4,3	20,7	9,8	0,06	0,61	2,64	12,7
Ireland	3,1	14,0	8,6	0,27	1,11	2,30	16,5
Italy	5,2	154,4	10,7	0,17	9,83	26,31	17,0
Latvia	34,9	5,9	40,4	0,04	0,09	2,48	41,9
Lithuania	15,0	6,1	20,5	0,04	0,14	1,40	22,8

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[136] The additional effort can be expressed mathematically as: DeltaRES = RES (2020) – RES (2005) = 20%*CONS(2020) – RES (2005). It is required that the RES percentage in 2005 of each Member State plus a common fix percentage X multiplied by the Final Energy Consumption of 2020 of each Member State, adds up at EU level to the initial RES production plus half of the additional effort:

Σi=1 to 27 (RESi (2005)/CONSi (2005) + X%)* CONSi (2020) = RESEU (2005) + 0.5*DeltaRESEU

The value of X can be derived by rearranging and substituting:

X% = [(RESEU (2005) + 0.5*DeltaRESEU – Σi=1 to 27 RESi (2005)/CONSi (2005)* CONSi (2020)]/CONSEU (2020)

Luxemb.	0,9	4,7	6,4	0,45	0,20	0,50	10,7
Malta	0,0	0,7	5,5	0,08	0,03	0,07	10,3
Netherl.	2,4	53,2	7,9	0,22	3,52	7,71	14,5
Poland	7,2	71,6	12,7	0,04	1,69	10,77	15,0
Portugal	20,5	21,6	26,0	0,10	1,03	6,63	30,7
Romania	16,5	34,9	22,0	0,03	0,55	8,24	23,6
Slovakia	6,7	12,8	12,2	0,05	0,26	1,82	14,2
Slovenia	16,0	6,3	21,5	0,10	0,19	1,55	24,6
Spain	8,7	115,8	14,2	0,14	6,23	22,63	19,6
Sweden	38,9	34,5	44,4	0,23	2,03	17,35	50,03
UK	1,3	148,1	6,8	0,21	12,47	22,50	15,2
EU-27	8.4	1270.6	13,9	0,16	76,1	254,1	20,0

* adjusted for early action by taking into account one third of the increase of the RES share between 2001 and 2005 for those Member States that have increased their RES share by at least 2 percentage points over this period; without this adjustment the non adjusted (2005) starting points would be 6.1% for the Czech Republic, 17.0% Denmark, 18.0% for Estonia, 17.8% for Romania and 39.8% for Sweden.

Finally, the targets were capped to ensure that no Member State has a renewable energy share of 50% or more and rounded down from half a percentage point.

In the table below, the results of the above flat rate method based on the reference scenario (A) were compared with results based on an alternative (DG TREN) PRIMES high renewables and efficiency scenario (assuming vigorous energy efficiency measures along the lines of the Action Plan for Energy Efficiency) (B), with non normalised hydro data for 2005 (C), and to test for sensitivity to changes in the base year, with data for 2000 and 1997 (NB: columns (B) to (F) do not contain the above mentioned early action adjustment that is included in the numbers in column (A); columns (C) to (F) are based on the reference scenario as is column (A):

	A	B	C	E	F
	Targets: Total RES	2005 Base year (high efficiency and RES	2005 Base year non-normalised hydro	2000 Base year	1997 Base year
	%	%		%	%
Austria	34,5	34,4	34,4	37,4	37,8
Belgium	13,2	13,2	13,3	12,9	13,0
Bulgaria	16,1	16,3	17,4	15,1	11,2
Cyprus	13,2	13,1	13,4	13,5	13,5
Czech Rep.	12,7	14,0	14,1	10,5	10,9
Denmark	30,1	31,0	31,9	27,4	25,4
Estonia	24,7	25,7	25,7	23,9	23,4
Finland	38,2	38,1	38,3	39,2	37,1
France	23,0	22,8	22,3	24,1	24,7
Germany	18,3	18,1	18,5	17,3	16,9
Greece	18,0	17,9	18,7	19,2	19,4
Hungary	12,7	12,8	12,8	11,6	11,9
Ireland	16,5	16,1	16,6	16,5	16,9
Italy	17,0	16,8	16,8	17,4	17,6
Latvia	41,9	42,1	42,6	42,7	39,6
Lithuania	22,8	22,9	23,0	24,8	20,2
Lux.	10,7	10,7	10,9	11,2	11,5
Malta	10,3	10,2	10,4	10,9	11,2
Netherl.	14,5	14,3	14,7	14,4	14,7
Poland	15,0	15,1	15,1	14,7	14,1
Portugal	30,7	30,6	27,4	30,4	33,1
Romania	23,6	25,1	26,3	24,2	22,4

Slovakia	14,2	14,4	14,6	11,0	11,1
Slovenia	24,6	24,6	23,5	25,4	20,6
Spain	19,6	19,3	18,6	19,8	20,4
Sweden	49	50,8	52,2	49,3	49,0
UK	15,2	15,2	15,4	15,7	16,2
EU-27	20,0	20,0	20,0	20,0	20,0

The results for the flat rate/GDP 2020 targets are summarised in the table below (rounded), together with the required increase from 2005 levels (percentage points).

Flat rate/GDP %		**Increase %**
AU	34	11
BE	13	11
BG	16	7
CY	13	10
CZ	13	7
DK	30	13
EE	25	7
FI	38	10
FR	23	13
GE	18	13
GR	18	11
HU	13	8
IR	16	13
IT	17	12
LA	42	7
LI	23	8
LU	11	10
MA	10	10
NL	14	12
PL	15	8
PT	31	10
RO	24	6
SK	14	8
SLOV	25	9
SP	20	11
SW	49	10
UK	15	14

8.7. Annex 7

Assessment of methods for calculating estimated greenhouse gas emissions from transport fuels

A. Introduction

This Annex expands on section 6.5.7.1.2 (ii) to set out the recommended approach to the calculation of estimated greenhouse gas emissions and the reasoning behind the choices made.

B. Overall approach

5. Recommendation: The same methodology should be used for the calculation of greenhouse gas impacts of transport fuels under this Directive and under the proposed amendment to the Fuel Quality Directive (Directive 98/70 as amended).

Reasoning: Under the proposed amendment to the Fuel Quality Directive, fuel suppliers will have to report on the greenhouse gas emissions attributable to all the motor fuel they sell. The methodology of calculation has not yet been determined. In the Commission's proposal, this will be done through comitology after the Directive has been adopted. However, the Council's Presidency and the European Parliament's rapporteur have both suggested that the principles, at least, should be laid down on the face of the Directive.

Under this Directive on renewable energy sources as well as under the Fuel Quality Directive, it is fuel suppliers who will be required to make assessments relating to greenhouse gas impacts of fuels. It would not be desirable or scientifically credible to create a situation under which a different value could be reported for one of these purposes than for the other.

Therefore, it is recommended to use the same methodology for both Directives. As well as basing the present legislative proposal on the methodology assessed here, the Commission will also use its role within the inter-institutional system to ensure that the same methodology is selected for the purposes of the Fuel Quality Directive.

C. Coverage of the whole chain

6. Recommendation: The methodology should take into account greenhouse gas emissions throughout the processes of production and use of fuels, including the effects of land use change.

Reasoning: One of the purposes of the present Directive is to reduce greenhouse gas emissions. It is possible to produce biofuels in ways which do not do this.

The proposed criterion for a minimum level of greenhouse gas savings should prevent this happening, and ensure that biofuels always make a positive contribution (at the level set by the cut-off). A calculation method that only covers part of the chain of production and use of fuels would not be suitable for this purpose. Covering the whole chain includes taking into account the greenhouse gas emissions as a result of land use changes.

The additional demand created by the EU's biofuel target will be met through increased use of waste materials such as used cooking oil; productivity increases in agriculture that are faster than they otherwise would have been; and conversion of land from other land uses to arable and plantation use[137].

In general, the conversion of land from other land uses to arable and plantation use involves a reduction in the level of stored carbon, because wetlands and forests – the typical sources of land for conversion - generally have a higher level of stored carbon (in soil and vegetation) than arable land.

Such acts of land use conversion therefore cause carbon to be released into the atmosphere, where it combines with oxygen to form CO_2 and contribute to climate change.

Such acts of land use conversion for the purpose of biofuel production would cause the biofuels in question to fail to meet another of the proposed sustainability criteria.

However, such land use conversion also takes place for the purpose of fossil fuel production, to which this other sustainability criterion will not apply. The existence of this other criterion does not, therefore, remove the need for the greenhouse gas assessment scheme to include rules concerning land use conversion.

In addition, conversion of land for the purpose of producing raw materials for biofuels will lead in some cases to an increase in the land's carbon stock. Examples are the planting of desert with jatropha and the planting of oil palms on land that has already been deforested.

Not to take into account the consequence of these types of land use change would mean that potentially significant effects would be ignored.

7. Recommendation: The manufacture of machinery and equipment should not be taken into account.

Reasoning: It has been estimated that this factor is *de minimis*. In the light of this, it is reasonable to lighten the administrative load by not taking it into account.

8. Recommendation: Emissions from the fuel in use shall be zero for biofuels.

Reasoning: The CO_2 emitted when biofuels are combusted was absorbed when the crops for biofuels were grown. This is the short carbon cycle that makes biofuels renewable and this should be accounted for. It is more practical to take this factor into account through this rule than by accounting for it in the cultivation of biomass.

9. Recommendation: Emissions shall be reported as CO_2 equivalent/MJ for the purposes of measuring greenhouse gas intensity and as percentage greenhouse gas savings, measured in terms of CO_{2eq}/MJ and relative to a fossil fuel comparator, for the purposes of reporting greenhouse gas savings

Reasoning: The basis for comparison should be the energy content of the different fuels, because this is a measure of the relative amount of useful work that they can do and hence their substitutability one for the other. For the purposes of this Directive a measure in terms of

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[137] This assessment relates to the raw materials used to make first-generation biofuels. With the development of second-generation biofuel production processes, residues and forestry products should be added to the list. This does not change the general analysis, however.

percentage greenhouse gas saving is appropriate since the purpose of this provision of the Directive is to ensure that these savings reach at least a minimum level.

10. Recommendation: The methodology should allow for the possibility of differences between fuels in useful work done (km travelled per MJ), including by the use of additives.

Reasoning: In the stakeholder work, some stakeholders argued that ethanol, biodiesel or other biofuels have qualities which make a measure in terms of energy content a misleading measure of the useful work these fuels can actually do. If this is the case, it would be appropriate to take it into account. However, proponents would have to provide evidence in order for such claims to be taken into account.

D. Greenhouse gases included

11. Recommendation: The methodology should assess emissions of CO_2, N_2O and CH_4.

Reasoning: It has been estimated that in the case of transport fuels, the impact of other greenhouse gases is *de minimis*. In the light of this, it is reasonable to lighten the administrative load by not taking them into account.

12. Recommendation: For the purpose of comparing the global warming impact of different greenhouse gases, the time horizon should be taken as 100 years, without discounting of the future relative to the present. The global warming potential of CH_4 (relative to CO_2) should be taken as 23. The global warming potential of N_2O should be taken as 296.

Reasoning: These are the rules applied by the IPCC. It is appropriate also to apply them here.

13. Recommendation: N_2O emissions from soil should be taken into account according to sound scientific evidence.

In a recent publication by Crutzen *et al.*[138]. it has been argued that the N_2O emissions from agriculture are much higher than the results of calculations according to IPCC methodology would give. However, the argumentation of this publication can be questioned:

- The methodology used is a global, top-down analysis and it is not evident why this method should be more accurate than values supported by field studies;

- Several of the figures used in the publication are not correct; critics comment that use of the correct figures would result in significantly lower N_2O emissions than the publication estimates[139];

- The methodology does not take into account the whole life-cycle either for biofuels or for the fossil fuels with which they are compared;

- The issue of co-products, which plays an essential part in estimating the greenhouse gas impact of biofuels, is ignored. A significant part of the harvested part of biofuel crops is used for co-products that are used for other energy uses or often as animal feed. Part of the N_2O

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[138] P.J. Crutzen et al., N_2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels, August 2007.

[139] On http://www.cosis.net/members/journals/df/article.php?paper=acpd-7-11191

should thus be assigned to the co-products and not to the biofuel. When biofuel co-products are used for animal feed they avoid the use of products (other sources of animal feed) that are associated with high N_2O emissions.

Crutzen *at al.* themselves agree that there is potential for over-interpretation of the results they present.

Therefore, N_2O emissions are more appropriately taken into account using methods developed by the Commission's Joint Research Centre or appropriate IPCC methods.

E. Fossil fuels and the fossil fuel comparator

14. Recommendation: Certified reductions of greenhouse gas emissions from flaring at oil production sites anywhere in the world should be taken into account.

Reasoning: Flaring is an important source of greenhouse gas emissions from the production of petroleum-based fuels. It is therefore appropriate to take both flaring and reductions in flaring into account.

15. Recommendation: The methodology should take into account Carbon Capture and Sequestration (CCS) of greenhouse gas emissions directly related to the extraction, transport, processing and distribution of fuel. The methodology should take into account Carbon Capture and Replacement of CO_2 where the carbon originates from biomass and used to replace fossil-derived CO_2 used in commercial products and services.

Reasoning: CCS has a large potential to reduce greenhouse gas emissions from fossil fuel production. It is therefore appropriate to take it into account.

Biofuel production that use a fermentation process produces CO_2 in that process that is of renewable origin. When this is captured and used in commercial products and services, such as beverages, the biofuel plant does not emit this CO_2, but instead the renewable CO_2 replaces CO_2 from fossil origin. It is appropriate to take this into account.

16. Recommendation: To establish the greenhouse gas saving from fuel other than petrol or diesel for the purposes of this Directive, emissions from their production shall be compared with actual average emissions from petrol and diesel consumed in the EU as reported under the future amended version of Directive 98/70/EC.

Reasoning: In order to estimate greenhouse gas savings from biofuels for the purposes of this Directive, it is necessary to determine what type of fossil fuel would otherwise have been used. The following options were considered:

C. The fossil comparator is oil from an established onshore production facility in the Middle East;

D. The fossil comparator is the actual average emissions from petrol and diesel consumed in the EU;

E. The fossil comparator is the most expensive source of crude oil;

F. The fossil fuel comparator is the source of crude oil with the highest greenhouse gas emissions.

Options A, C and D all embody a "marginal" approach.

Proponents of Option A point out that today, most non-Middle East oil producers act as if they do not have market power. They do not alter their production volumes in response to changes in price or demand. Oil production requires high capital investment and has low operating costs. Once a particular investment has been made, it is possible to identify the optimal rate of exploitation of the crude oil resource to which this investment gives access. (The change in this rate over time can be depicted by a bell curve.) A profit-maximising producer without market power will produce at this optimal rate. (This would not be the case if the oil price fell below the producer's operating costs. But this has not happened at least since the 1930s.) Non-Middle East oil producers are considered to be price takers and to act in this profit-maximising way.

By contrast Middle Eastern producers, in particular Saudi Arabia, act as if they have market power. They are – to a degree – price makers rather than price takers. They can maximise their profits by acting strategically as "swing producers", determining the balance between supply and demand, and hence – to a degree – the price, by altering the volume of crude oil they put on the market.

For proponents of Option A, this analysis shows that the Middle East should be treated as the marginal source of oil – that is, the source of oil of which less will be consumed if more is consumed of some alternative such as biofuels.

Proponents of Option C fall into two groups. One group argues from economic theory that in a market economy the last unit of any good consumed should be expected to be the most expensive. The other group argues that in assessing the likely future mix of sources of crude oil, the critical factor will be the mix of investment decisions made by producers. Biofuel consumption as a substitute for oil-based products can be expected to lead to a reduction in the price of oil[140]. In turn, this can be expected to lead to the abandonment of those investments that are most price-sensitive. These are, of course, the most expensive. This can be seen as a long-run marginal approach compared to the short-run marginal approach of proponents of Option A.

Proponents of Option D argue that under all realistic scenarios for the achievement of the EU's objective of a 60-80% reduction in global greenhouse gas emissions by 2050 compared to 1990, it will be necessary to leave in the ground a significant amount of crude oil that would otherwise have been consumed – and, in particular, to leave in the ground the crude oil with the highest unit greenhouse gas emissions.

This will not happen if the driving force for oil production decisions is economic, as it is today. Therefore, those who believe that the objective of a 60-80% reduction in greenhouse gas emissions by 2050 will in fact be achieved must, logically, believe that the economic driving force behind oil production decisions will be replaced by a different driving force – one based, in particular, on greenhouse gas impact.

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[140] Economic theory makes, and can quantify, this prediction for a competitive market and for a monopoly. The oil market is probably best understood as an oligopoly. Economic theory is poor at predicting the magnitude of price effects under oligopoly. But no reasons have been advanced to suggest that their sign should be expected to be different than under other market structures.

If the driving force behind oil production is to be greenhouse gas impact rather than economic factors, it follows that the marginal fossil fuel – the fuel of which less is consumed, if more is consumed of some alternative such as biofuels – will be the fuel with the highest greenhouse gas emissions.

All the marginal approaches (Options A, C and D) share the disadvantage that the behaviour of the oil market is poorly understood. As illustrated by the passages above, many different theories on the topic, implying diametrically opposite conclusions, can be convincingly advanced. Any decision to work with marginal values would therefore be vulnerable to the criticism that some type of oil other than the one chosen should have been adjudged to be at the margin.

All three approaches have the additional disadvantage that the results they give are, in greenhouse gas terms, extreme. Middle Eastern oil is easy to extract and refine, giving rise to low emissions in the process. By contrast, option D evidently gives a result in which the avoided emissions from biofuel use are depicted to be as high as possible; and option C will not be far away from this, since the expensive, "non-conventional" sources of oil also give rise to high emissions. Rather than these extreme results, it seems more credible to believe that increased biofuel use will in fact lead to a reduction in all the main sources of future supply to the EU (both low-emission oil from the Middle East and higher-emission oil from the CIS countries); and that the small oil price reduction likely to result from the decreased demand for oil will deter the launching of some non-conventional oil projects, but not in the same volume as the additional consumption of biofuel.

Finally, Options C and D have the disadvantage that it is not obvious how to derive a marginal value attributable to individual consignments of biofuel. At the margin (whether defined in cost or in emission terms), the unit emissions curve for crude oil appears to rise quite steeply. It will make a difference, therefore, whether biofuel consignment *X* is adjudged to have avoided the use of the very last, most expensive/high-emission barrel of oil – or whether that honour is awarded to some other consignment, while consignment *X* is adjudged to have replaced some other unused barrel at a lower point on the cost-supply curve. There is no obvious rule to decide this.

For all these reasons, it is considered that compared with the three marginal options, an average-based approach (option B) offers a more reliable, defensible and practically applicable estimate of the types of oil use that will avoided as a result of increased biofuel consumption.

17. Recommendation: Data on actual average emissions from petrol and diesel shall be derived from fuel suppliers' reporting under the future amended version of Directive 98/70/EC. Until these data are available, the value used shall be 83.8 gCO_{2eq}/MJ.

Reasoning: reporting under Directive 98/70/EC will be carried out using the same methodology as is used for the purposes of this Directive, and will cover all significant consumption of petrol and diesel in the EU. It is therefore an appropriate source of the necessary data.

Under the Commission's proposal for the amendment of Directive 98/70/EC, full-year data on average emissions from petrol and diesel will not be available before 2010 or later. Interim values are therefore necessary. The table shows data on emissions from petrol and diesel production.

Table 39

Fuel/origin	**Emissions, well-to-wheel, gCO_{2eq}/MJ**	**Source**
conventional petrol produced in U.S.	94.2	LCFS[141]
conventional petrol produced in EU	78.1-88.8	JEC
conventional diesel produced in U.S.	93.5	LCFS
conventional diesel produced in EU	84.4-90.4	JEC
tar sands/extra heavy oil	107.8-131.6	LCFS
enhanced oil recovery	96.1-112.6	LCFS
oil shale	121.4-257.0	LCFS

In the absence of more comprehensive data than these, it is necessary to make a judgement about the interim value to be used. Previous European work (e.g. the JEC well-to-wheel study) has calculated greenhouse gas savings for biofuels using the middle values of the JEC-sourced ranges reported above. However, the method JEC have used to calculate the emissions in the refinery for petrol and diesel production cannot be used for reporting under Directive 98/70/EC (This is further explained in recommendation 14). Replacing that calculation with an appropriate method (energy allocation) results in somewhat lower emissions in the refinery for diesel and petrol production. It also results in figures that are similar for diesel and petrol. Therefore, the value used until data are available under reporting under Directive 98/70/EC is the value calculated by the JEC with a correction for the emissions in the refinery, resulting in a value of 83.8 gCO_{2eq}/MJ.

F. Co-products

Introduction: The purpose of this methodology is to assign greenhouse gas emissions to individual consignments of individual fuels. It often happens that a single production process produces, simultaneously, the fuel of interest and other products ("co-products"). Examples are the production of different petroleum-based products in refineries, and the production of products like meal and glycerine as part of biofuel production processes. Often, this co-production is inevitable. It is not possible to produce the fuel of interest without producing quantities of co-products at the same time. It is assumed that the quantity of emissions due to the combined production of "fuel + co-product" is known. The problem is to decide how much of this quantity should be ascribed to the fuel and how much to the co-product.

The methods that have been developed to tackle this problem fall into two groups:

1) The *substitution approach*. This approach involves the following steps:

   i) determine what the co-product is used for;

   ii) determine what product would otherwise have been used to perform this function (the "substituted product");

   iii)find out the greenhouse gas emissions that would have been caused by the production of the substituted product;

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[141] A.E. Farrell, D. Sperling, A Low-Carbon Fuel Standard for California: Part 1 Technical Analysis, August 1, 2007.

iv) subtract these emissions from the total emissions caused by the production of "fuel + co-product".

The remaining emissions are ascribed to the fuel of interest.

2) The *allocation approach*. Under this method, total emissions are divided between the fuel of interest and the co-product in proportion to some attribute that they share:

- *allocation by mass*;
- *allocation by energy content*; or
- *allocation by economic value.*

These are the approaches and methods examined in the analysis below[142].

In assessing these approaches and methods, it is important to distinguish between the assessment of greenhouse gas emissions for policy analysis purposes and for regulatory purposes. The former involves the assignment of greenhouse gas impacts to the overall changes that a policy brings about. The latter imposes a more fine-grained approach, assigning greenhouse gas impacts to individual consignments of biofuel.

Many authorities have concluded that the substitution approach is the most appropriate for policy analysis purposes. In the European context these authorities include, notably, the JEC consortium, which used the substitution approach in its well-to-wheel study, often taken as a reference in this respect.

This conclusion makes sense. If the method is accurately applied, it seems indisputable that the substitution approach gives a best-estimate answer to the question, “What will be the overall difference in global greenhouse gas emissions between a scenario in which policy A is adopted and a scenario in which policy B is adopted?”. It is true that the method requires assumptions to be made - in particular, since the substituted products do not, in fact, exist, it is not possible to know for certain what they are. This requirement for assumption-making means that the method will not, in fact, be applied with full accuracy. But at the high level of aggregation that is appropriate for policy analysis, and as part of the scientific, objective method that ought to be used in such processes, there is no reason to suppose that the requirement for assumption-making will give rise to systematic distortion. The Commission used the substitution approach for the purpose of policy analysis in its biofuels progress report[143] and has no plans to cease using it for this purpose in future.

However, the task here is different. It is to solve two regulatory problems:

- how to ascribe greenhouse gas impacts to individual consignments of fuel produced in refineries;

- how to ascribe greenhouse gas impacts to individual consignments of biofuel that are produced simultaneously with non-fuel co-products.

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[142] Hybrid methods can also be considered. For simplicity of exposition they are not examined here.

[143] COM(2006) 845.

In this regulatory context, the substitution approach gives rise to problems of feasibility, risk of distortion, investor uncertainty and perverse incentives that are not present, or not relevant, when the approach is used for policy analysis purposes. These problems require the merits of the substitution approach to be weighed against those of the different allocation methods; this will be attempted in the sections below.

18. Recommendation: Emissions from co-products from refineries should be divided between them using allocation by energy value.

Reasoning: It is not feasible to use the substitution approach to assign greenhouse gas emissions to the overall fuel production of refineries. To illustrate this point it can be assumed, for simplicity, that the refinery produces only two fuels: diesel and petrol. Total emissions from the production of "diesel + petrol" are known. The problem is to divide them between the two fuels. In considering the production of one of these fuels – for example, diesel – the other fuel, petrol, must be considered as a co-product.

To apply the substitution approach in calculating the greenhouse gas emissions attributable to the production of diesel, the first step would therefore be to determine how the petrol is used. Again for simplicity, it can be assumed that it is all used to fuel cars. The second step would be to determine what product would have been used to perform this function, if petrol had not been used. Two answers are possible:

a) there is no alternative – petrol cars need to run on petrol[144];

b) in the absence of petrol, the car would be adapted to run on another refinery-produced fuel or would be replaced by a car that can use such fuel (e.g. a diesel car);

Clearly, the terms 'diesel' and 'petrol' can be reversed in this analysis, leading to the same conclusion in the case of petrol production. In assessing these answers, it is useful to recall the steps that have to be applied in order to implement the substitution approach:

i) determine what the co-product is used for;

ii) determine what product would otherwise have been used to perform this function (the "substituted product");

iii) find out the greenhouse gas emissions that would have been caused by the production of the substituted product;

iv) subtract these emissions from the total emissions caused by the production of "fuel + co-product".

If answer a) is followed, the procedure fails at step i). It is not feasible to apply the substitution approach because it is not possible to determine a product that is substituted by the co-product.

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[144] In fact, most can run on blends that include 10% or more of ethanol. But because the majority of the blend has to be petrol, this does not invalidate the argument made here.

If answer b) is followed, the procedure fails at step iii). It is not feasible to apply the substitution approach because the reasoning becomes circular. The greenhouse gas emissions attributable to diesel production are a function of those attributable to petrol production, and vice versa. It is only possible to know the emissions attributable to diesel production if those attributable to petrol production are already known; and it is only possible to know the emissions attributable to petrol production if those attributable to diesel production are already known. This problem has no solution.

This is why the use of the substitution approach to assign greenhouse gas emissions to the overall fuel production of refineries is not considered to be feasible. In its well-to-wheel study, the JEC consortium overcomes this problem by using a model to calculate the marginal change in emissions that would be caused by a decision to decrease a refinery's production of petrol or diesel by a small amount, while keeping the production of other fuels constant.

This assumption was an appropriate choice in the context of the well-to-wheel study's policy analysis objective, which was, precisely, to estimate the impact of alternative fuels such as biofuels replacing a small amount (5%) of the petrol or diesel consumption that would otherwise occur.

As a matter of principle, it would not be appropriate to use the marginal approach to ascribe emissions to fossil fuels under the Fuel Quality Directive, because that Directive requires Member States to require fuel suppliers to report on and reduce the greenhouse gas impact of all their fuel production, not merely their marginal fuel production.

As stated above, it is appropriate for the same methodology to be used under this Directive and the Fuel Quality Directive. It follows, therefore, that the marginal approach to ascribing emissions to fossil fuels ought not to be used, either, for the purposes of this Directive.

19. Recommendation: Emissions from transport fuels and their co-products should be divided between them using allocation by energy value. Emissions that take place up to and including the process step at which a co-product is produced shall be divided between the biofuel or its intermediate product and the co-products in proportion to their energy content.

Reasoning:

Feasibility of using the substitution approach

Unlike in the case of conventional fuels, it is, in principle, feasible to use the substitution approach to divide the greenhouse gas emissions from "biofuel + co-product" production between the biofuel and the co-product (except in the case of biofuels that are produced in refineries as part of multi-fuel production processes).

Application of the substitution approach in practice

Compared to the allocation approach, the substitution approach imposes three additional tasks on fuel suppliers:

i) To find out what the biofuel co-product has been used for;

ii) To make a claim about the product that would otherwise have been used to perform this function;

iii) To find out the greenhouse gas emissions associated with the production of this substituted product.

The first and third tasks are no more difficult than the other acts of tracking and data gathering required for the implementation of the recommended environmental sustainability criteria[145].

Since it is not possible to know for certain what the substituted product really is, the second task requires the making of an assumption.

Three rules could be applied to this act of assumption-making:

a) Fuel suppliers are required to make an assumption that is accurate. Member States are required to verify its accuracy[146].

b) “Default assumptions” are laid down in the Directive. Fuel suppliers may use the default assumptions without constrain; or may make alternative assumptions provided that they provide evidence for these. Member States are required to verify the accuracy of the alternative assumptions.

c) The Directive lays down definitive rules on the assumptions to be used. Fuel suppliers must use these assumptions and may not use others. The assumptions are modifiable through a comitology procedure.

Assessment of options for implementing the substitution approach, and of implications for the accuracy of the results given

Many of the functions performed by co-products are capable of being performed by more than one substituted product. For example, co-products used as animal feed can replace many different animal feed products. These different substituted products have differing greenhouse gas performances. If the rule laid down in the Directive is that the assumed substituted product is one whose production entails relatively low greenhouse gas emissions, objections could be expected from those producers who can bring evidence that in the market in which their co-product is sold, it competes only with higher-emission products. If the rule laid down in the Directive is that the assumed substituted product is one whose production entails relatively high greenhouse gas emissions, objections could be expected from producers of competing biofuels, bringing evidence that the chosen assumption is overstating the greenhouse gas benefits of the biofuel in question. Rule c) is not considered to be defensible scientifically or (in WTO terms) legally.

If the substitution approach were to be applied, the rule applied to the act of assumption-making would therefore have to be either rule a) or rule b). Both rules grant discretion to fuel suppliers in the claims they make. Fuel suppliers will have an incentive to make claims that err on the favourable side.

Member States will be responsible for verifying these claims, as for other claims made in respect of the environmental sustainability criteria in this Directive. However, there is an important difference between the claims that fuel suppliers will make in relation to the other sustainability criteria, and those that they would have to make, in relation to substituted

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[145] These tasks do, however, imply an additional administrative burden. Since the Commission believes that the other arguments against the use of the substitution approach are enough, in themselves, to point against the use of this approach, this administrative burden has not been quantified.

[146] In the discussion that follows, the term “Member States” should be taken to include certified verification schemes where appropriate.

products, if the selected method of dealing with biofuel co-products were to be the substitution approach.

In the case of the other sustainability criteria, claims are unambiguously true or false. The raw material used to make the biofuel was or was not produced at a particular map location; the quantity of fertiliser used was or was not X kg per hectare; etc. It is reasonable, therefore, for Member States to test fuel suppliers' claims by asking them to provide proof of these claims; it is reasonable for fuel suppliers to expect to be asked, from time to time, to provide such proof, and to avoid making over-favourable claims in the expectation that this will happen.

In the case of substituted products, no such absence of ambiguity exists because the substituted product itself does not exist. Member States cannot reasonably ask fuel suppliers to provide proof of the claims they make on this topic because these claims are inherently incapable of proof.

Member States will be obliged to apply a lower standard of verification, accepting fuel suppliers' claims unless these are inherently unconvincing.

Knowing this, fuel suppliers will not necessarily feel obliged to rein in their natural tendency to select, among the set of claims that are not inherently unconvincing, the claim that is most favourable for their production pathway.

It follows that the substitution approach will have a systematic tendency to produce evaluations of biofuels' emission performance that are over-positive.

The substitution approach has never been applied as a practical regulatory tool. No evidence is therefore available that would permit the estimation of the extent of this systematic bias.

Implications of the substitution approach for investor certainty

Rules a) and b) have an additional disadvantage. Under the Fuel Quality Directive and this Directive, the volume of greenhouse gas emissions ascribed to particular biofuel production processes will affect these production processes' profitability. Investors make judgements about profitability in deciding whether to invest in biofuel production plants. Profitability will always be uncertain. Rules a) and b) introduce additional uncertainty by making the outcome of one aspect of the emissions calculation dependent on an unpredictable process of Member State verification. This uncertainty will deter investment and increase the cost of capital for biofuel producers.

Assessment of undesirable incentives under the substitution approach: land use change

Today, the main choices for most biofuel by-products are whether to use them for animal feed or for energy purposes.

As the table shows, energy use of co-products is estimated, under the substitution approach, to deliver greenhouse gas savings that are 10-30% better than those delivered by use for animal feed.

Table 40

biofuel production pathway	**greenhouse gas savings according to substitution approach**	
	co-product used for animal feed	co-product used for energy
rape seed biodiesel	38%	69%
sunflower biodiesel	64%	86%
sugar beet ethanol	31%	65%
wheat ethanol (processing: conventional natural gas boiler)	29%	40%

Source: JEC well-to-wheel study, 2006; calculations of Commission services

It follows that the substitution approach will create an incentive to use biofuel co-products for energy purposes rather than for animal feed.

The values in the table do not take land use change into account.

Two types of land use change are relevant:

(4) a) land use change caused by the conversion of land for the production of biofuels;

(5) b) land use change caused by the conversion of land for the production of the animal feed that would otherwise need to be produced if biofuel co-products were not available and used for this purpose[147].

Under the recommended approach to accounting for land use change, the land use change caused by biofuel production will be taken into account. If undesirable land use change occurs, the greenhouse gas savings attributed to biofuels will be lower (or negative). This will be the case whatever the use of the co-products.

However, the land use change that would have been caused by the production of the substituted product will not be taken into account under the recommended approach. (Indeed, it is difficult to see how it could be.)

If this avoided land use change were to be taken into account, the figures in the second column of the table would tend, on average, to be higher. The figures in the third column, on the other hand, would remain unchanged.

It is not feasible to take this avoided land use change into account in calculating the greenhouse gas impact of biofuels. If this factor were taken into account, incentives would shift in favour of the use of biofuel co-products for animal feed. Such a shift would be appropriate. Since this factor is not taken into account, incentives are shifted inappropriately in favour of the use of biofuel co-products for energy purposes.

The use of the substitution approach would therefore create an undesirable incentive to use biofuel co-products for energy purposes rather than as animal feed.

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[147] The energy products that would otherwise need to be produced if biofuel co-products were not available and used for this purpose may also have land use implications, but it is certain that these are on a smaller scale.

(The undesirability of this incentive is due to the fact that opportunities to avoid harmful land use change – by using biofuel co-products for animal feed – will be foregone.)

Assessment of undesirable incentives under the substitution approach: incentive to produce co-products rather than biofuels

As a general rule, greenhouse gas savings are easier and cheaper to obtain in other sectors than in transport.

It is the Commission's position that greenhouse gas savings in transport should nevertheless be pursued, even at a higher unit cost. This is because a scenario in which this key sector does not contribute to the necessary reduction of greenhouse gas emissions is not politically tenable in the short term and is unlikely to be the most economically efficient approach to obtaining the deep cuts in overall emissions that are needed to minimise global warming in the long term. It is also because the expression of data in terms of € per ton of CO_2 is misleading. Measures such as investment in renewable energy yield other benefits as well as greenhouse gas savings, and these benefits – notably in terms of security of supply – are especially well developed in the transport sector[148].

These are some of the reasons why the Commission has proposed a specific target for renewable energy in transport, an approach endorsed by Council and Parliament.

In this context it is desirable for the recommended method of assessing greenhouse gas emissions from biofuels to encourage the selection, among the range of biofuel production pathways, of those with better greenhouse gas performance. It is not desirable, on the other hand, for the recommended method to create an incentive for the share of biofuels in the total product of these pathways ("biofuel + co-product") to fall[149].

Under the substitution method, any increase in the ratio of co-product to biofuel has the effect of "diluting" the emissions attributed to the biofuel and thus of improving its apparent performance. It follows that the undesirable incentive described here is present when the substitution approach is used to attribute greenhouse gas emissions to biofuels.

Assessment of the substitution approach: conclusion

In conclusion, the substitution approach has substantial weaknesses when used for regulatory purposes. These are systematic and unquantifiable upward bias; increased investor uncertainty; and the creation of undesirable incentives.

Application of the allocation approach in practice

In applying the allocation approach, different methods can be used: allocation by mass; allocation by energy content; and allocation by economic value. If one of these methods has better performance than the substitution approach, this method, rather than the substitution approach, should be preferred.

In order to apply the mass allocation method, all that needs to be known is the mass of the biofuel and the co-product produced.

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[148] These arguments are set out in detail in the Commissions communication on Cars and CO_2 - COM(2007) 19).

[149] The share of biofuels can be made to fall in a variety of ways, for example, by optimising crops to produce a lower proportion of the components that are transformed into biofuel, or by selecting, among the crops available, those that produce small amounts of biofuel and large amounts of co-product.

To apply allocation by energy content, as well as the mass of the products, it is also necessary to know the energy content attributable to these products. Such information is widely available.

To apply allocation by economic value, as well as the mass of the products, it is also necessary to know the economic value that can or should be attributed to them.

The allocation approach is inherently simpler and less administratively burdensome than the substitution approach, because under this approach, the process of attribution of greenhouse gas emissions to consignments of biofuel has fewer steps.

Comparison between the allocation approach and the substitution approach: accuracy

Accuracy is assessed by comparing the results with those that would be given by the substitution approach if it were applied as defined in theory. As set out above, it is clear that the results of the substitution method in practice will be more favourable to biofuels than those it gives in theory. However, no data are available on the likely extent of this distortion.

Results for the different allocation methods are set out in the table. Annex 7B contains additional results.

Table 41

	rape seed biodiesel	**sunflower biodiesel**	**sugar beet ethanol**	**wheat ethanol produced in conventional natural gas boiler**	**sugar cane ethanol**
substitution in theory					
co-product to animal feed	38%	64%	31%	29%	n.a.
co-product to energy	69	86	65%	40%	88%
co-product not used	?	?	?	?	75%[150]
substitution in practice					
co-product to animal feed	?	?	?	?	?
co-product to energy	?	?	?	?	?
co-product to chemical	?	?	?	?	?
mass allocation	60%	69%	60%	57%	77%
energy	44%	59%	49%	45%	77%

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[150] This figure depicts the situation in which bagasse (the co-product of sugar cane ethanol) is used for process fuel, but no use is made of the surplus bagasse.

allocation					
economic value allocation	36%	49%	29%	19%	75%

Source: JEC well-to-wheel report plus calculations of Commission services

It can be seen that in nearly all cases, allocation by mass gives results that are close to or above the upper limit of the range of results possible under the substitution approach as it would be applied in theory.

In nearly all cases, allocation by economic value gives results that are close to or below the lower limit of the range of results possible under the substitution approach as it would be applied in theory.

Among the three allocation methods, it is the results given by energy allocation that tend to come closest to those that would, in theory, be given by the substitution approach.

Among the three allocation methods, it is therefore the energy allocation approach that should be preferred on grounds of accuracy.

Because there is no practical experience of the degree to which the results of the substitution approach as applied in practice will differ from those that would be given by this approach in theory, it is not possible to compare the accuracy of the energy allocation method and the substitution approach. It seems reasonable to suppose, however, that the two methods have similar levels of inaccuracy – at least in comparison with economic and mass allocation.

Comparison between the allocation approach and the substitution approach: investor certainty

Mass allocation and energy allocation use known, unchanging factors to divide emissions between biofuels and co-products. Under economic allocation, this division relies on a constantly changing variable (economic value). It follows that economic allocation shares the weakness of the substitution approach in this respect, while mass allocation and energy allocation do not.

Comparison between the allocation approach and the substitution approach: undesirable incentives

Under the allocation methods, the use that is made of the co-product is not taken into account. It follows that all the allocation methods avoid the creation of an undesirable incentive to use co-products for energy purposes rather than as animal feed.

The undesirable incentive to maximise the ratio of co-products to biofuel is present with all three allocation methods, but in a less acute form than under the substitution approach.

Conclusion

Based on the above analysis, among the three allocation methods, energy allocation is preferable both to economic allocation and to mass allocation on grounds of accuracy. Energy and mass allocation are preferable to economic allocation on grounds of investor certainty. It is therefore recommended to prefer the energy allocation method relative to the other two methods of allocation.

Neither energy allocation nor the substitution approach in practice will give figures that are the same as those given by the substitution approach in theory. It is not possible to compare the accuracy to be expected from the two approaches, the likely inaccuracy of the energy allocation approach can be quantified, while that of the substitution method cannot.

Energy allocation avoids the problems for investor certainty posed by the substitution approach. It avoids the problem of creating undesirable incentives for the energy use of co-products rather than their use as animal feed. It reduces but does not avoid the problem of undesirable incentives to produce more co-product and less biofuel.

Based on this analysis, it is recommended to use the energy allocation approach.

20. Recommendation: when accounting for co-products using the energy allocation method, all co-products, including electricity (except when it is produced by fuel production systems that use cogeneration and a fuel other than a co-product that is not an agricultural crop residue) shall be taken into account for the purposes of this calculation, except for agricultural crop residues, including straw, bagasse, husks, cobs and nut shells. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purpose of the calculation.

Reasoning: The crops used for biofuels can be thought of as having three components: a) the parts that are used to make the biofuel; b) the parts that are generally used for some other purpose; c) agricultural crop residues. The residues account for a significant proportion of the total energy content. However, often these residues are not used other than on the field itself. In addition, the agricultural crops are not grown for their crop residues, nor do the residues influence the choice of what crop to grow, whereas other co-products usually do influence e.g. investment decisions. If the residues were to be included when accounting for co-products a significant part of the inputs for agricultural production would be allocated to the agricultural crop residues and the greenhouse gas balance of the biofuel as a result would appear be much better. This approach would, however, fail the test for accuracy presented in the reasoning for what method to use to account for co-products. Therefore, it is recommended that agricultural crop residues shall not be taken into account when accounting for co-products using energy allocation.

The issue of electricity produced by fuel production systems that use cogeneration is addressed under 'Cogeneration and electricity'.

Products that contain a large amount of water can have a negative energy content measured by lower heating value. (This means it costs energy to burn the product instead of delivering energy, because of the energy needed to evaporate the water.) It is not possible to allocate between a positive and a negative figure. Therefore, it is recommended that any co-products that have a negative energy content shall be considered to have an energy content of zero for the purpose of the calculation.

If a co-product is used in the biofuel production process, e.g. as an energy source, no emissions should be allocated to it since this would lead to double counting as the product has already been taken into account as being a source of process energy with no greenhouse gas emissions attributed to it. Therefore, it is recommended that material that is used in the biofuel production process shall not be considered to be a co-product for this purpose.

21. Recommendation: Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, residues from processing chains, other than biofuel processing chains, *with no potential food or feed use shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of these materials.*

Reasoning: It is recommended above that, in applying the method of energy allocation to account for co-products, no agricultural emissions should be allocated to agricultural crop residues It follows that if agricultural crop residues are actually used in biofuel production, whether as a process fuel or as a feedstock, no upstream life-cycle greenhouse gas emissions should be allocated to them, as these greenhouse gas emissions should be allocated to the main crop product. For waste and some other materials a similar rule is necessary as otherwise it would not be clear where the life-cycle starts when taking into account the use of waste in biofuel production. Therefore, it is recommended that wastes and agricultural crop residues shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of these materials.

G Cogeneration and electricity

22. Recommendation: In accounting for the excess electricity produced by fuel production systems that use cogeneration and a fuel other than a co-product that is not an agricultural crop residue, the size of the cogeneration unit should be assumed to be the minimum necessary to supply the heat supplied by the cogeneration unit that is needed to produce the fuel. The greenhouse gas emission savings associated with this excess electricity shall be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

Reasoning: This rule is needed to ensure a correct balance between two objectives: a) encouraging the use of cogeneration for heat and electricity used in biofuel production processes; b) avoiding creating an incentive to maximise the production of electricity (as opposed to biofuels) simply in order to achieve a higher apparent greenhouse gas saving for the biofuel.

Cogeneration is an efficient process to generate electricity and heat. Certain biofuel production processes use heat and electricity. However, the ratio of heat and electricity used in those processes is usually not the same as the ratio in which they are produced in cogeneration. In general, the ratio of heat vs. electricity required by those biofuel production processes is higher than is produced in cogeneration.

The cogeneration unit could be sized in three ways:

a) Producing the exact amount or less of the electricity needed for the biofuel production process. It thus produces less heat than needed for the process.

b) Producing more electricity than needed for the process, but not more heat than needed for the process.

c) Producing more electricity and more heat than needed for the process.

If a cogeneration unit of size a) is used there is no additional rule necessary as all the energy produced by the cogeneration unit is used in the biofuel production process. Apart from the fact that the energy is produced more efficiently, there is no difference compared to the situation where heat and electricity are produced separately.

For the biofuel production process, there is no reason to have a cogeneration unit of size c). If such a very large co-generation unit is used and accounted for without an additional rule, the calculation of the greenhouse gas emissions would not concern just the system of biofuel production, but a system of electricity and heat production with biofuel as by-product. As the greenhouse gas assessment method is designed for the purpose of assessing emissions associated with the production of transport fuels only, this should be avoided. Therefore, in accounting for the excess electricity produced by cogeneration, the size of the cogeneration unit should be assumed to be the minimum necessary to supply the heat supplied by the cogeneration unit that is needed to produce the fuel. It is recommended to use this approach.

If a cogeneration unit of size b) is used, excess electricity is produced - sometimes in significant quantities. If no additional rule were to be applied in accounting for this excess electricity, it would be considered as a co-product in the greenhouse gas calculation methodology. The difference with other co-products, however, is that those other co-products are produced from the same (biomass) source as the biofuel, whereas the excess electricity generated by cogeneration is produced from a separate fuel, which can be, for example, biomass, natural gas or coal. The type of fuel used influences the greenhouse gas emissions of the biofuel produced. It is logical to take this into account for the electricity (and heat) actually used in the production of the biofuel. However, if the excess electricity were to be taken into account in the same way, the greenhouse gas emissions life-cycle considered would not concern just biofuel production, but a system of biofuel + electricity production from two different feedstocks/fuels. Therefore, excess electricity should be treated by a different rule, so that the greenhouse gas performance of the biofuel does not depend on excess electricity produced from an external fuel. (There is no issue when a *biofuel co-product* is used for the cogeneration. In that case it is just one of the possible uses of the co-product.)

In order to account for the biofuel system only and not for the biofuel + electricity system the excess electricity from cogeneration should have an effect on the greenhouse gas emission calculation that is not affected by what fuel is used for the cogeneration. This can be done by assigning greenhouse gas emission savings associated with this excess electricity equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit. It is recommended to use this approach.

23. Recommendation: In accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emission intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region. In exception to this rule:

a) producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid;

b) producers may ascribe an emissions intensity of zero to each MWh of consumed electricity for which they transfer a guarantee of origin to a competent body in accordance with the provisions of the Directive.

Reasoning: It is difficult to determine the marginal electricity source for a specific market, whereas it is not difficult to determine the average value. Therefore, it is recommended that average values rather than marginal values shall be used.

It is impossible to give electricity GHG values for individual production sites, except when the electricity used is not from the grid. Therefore, it is recommended that averages for defined region shall be used, but that producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.

If a production site has a long term contract for its grid-borne electricity, it could be argued that it can use the GHG value of the electricity covered by this contract for its individual production site. However, if this is a contract for renewable electricity, this seems to lead to double counting with RES use in the electricity sector. The fact that a RES-E producer makes a contract with a refinery to supply green electricity does not necessary mean that the RES-E producer produces more green electricity. In particular, there would be a natural temptation for existing large hydro plants to put themselves forward as suppliers in this market. Therefore, it is recommended that when using grid electricity, deviation from the general rule shall only be allowed in case of transfer of guarantees of origin to a competent body in accordance with the provisions of the Directive and that the producers may then ascribe an emissions intensity of zero to each MWh of consumed electricity for which they transfer a guarantee of origin.

H Land use change

24. Recommendation: In accounting for land use change, it should be assumed that if not producing biofuels, the land would keep the same use as it had on a reference date.

Reasoning:

Four options were assessed:

1) Assume that the land would be used in the same way, whether biofuels are produced or not;

2) Assume that if not producing biofuels, the land would keep the same use as it had on a reference date;

3) Assume that the land would (on average, or typically) otherwise have some other, defined “reference” use (based on empirical analysis);

4) Except in the case of “idle” land, assume that the land would otherwise have the use that has the highest plausible C stock – for example, forest.

Option 1 is rejected on the grounds of inaccuracy because it fails to take land use change effects into account, even where they exist. It will divide biofuels into two groups: those for which the effect of land use change is correctly accounted for (because there is, in reality, no effect) and those for which the effect is understated (because there is an effect, but this has been ignored.)

Option 4 is also rejected on the grounds of inaccuracy, albeit that its bias lies in the opposite direction. It will divide biofuels into two groups: those for which the effect of land use change is correctly accounted for (because the land would indeed, in reality, otherwise have been forest) and those for which the effect is overstated (because there is, in reality, no effect, or because the land would otherwise have been in a use with lower carbon storage than forest).

Option 3 is unattractive because it requires data that are not obtainable and relies on assumptions that are neither consensual nor well-tested. There is no known working example of a scheme using such a criterion.

Both option 3 and option 4 would apply a land use change penalty to all consignments of biofuel (except for "idle land" under option 4). They would not create any particular disincentive to individual acts of land conversion. This is an additional disadvantage.

Option 2 is attractive because it gives a result that is indisputably correct (albeit within defined system boundaries), and rests on data that are themselves unambiguous and relatively easy to obtain. It creates a significant disincentive to the conversion of land for biofuel production. This is the preferred option.

In the stakeholder work, some stakeholders advocated option 2 while others advocated option 1. For the most part, those that advocated option 1 argued that greenhouse gas effects of land use change should be tackled, instead, by bans on certain types of land use change. The approach recommended here is to use both instruments.

25. Recommendation: The carbon stock effect of land use change should be accounted for over a 20 year period, without discounting.

Reasoning: If the carbon stock (C stock) effects of land use change are to be taken into account, it is necessary to decide how to account for them.

This problem arises because the C stock effects of land use change and the greenhouse gas benefits of biofuel production are not of the same character. C stock effects of land use change can be thought of as one-off changes[151]. By contrast, the GHG benefits of using land to produce biofuel recur each year.

Methodologically, it is therefore necessary to decide over how many years the impact of the C stock change should be spread.

Four options were assessed:

1) By analogy with the calculation of the global warming potential (GWP) of different GHGs: assess the impact of C stock changes over 100 years with no discounting of the future relative to the present.

2) Switch to calculating GWPs as economics would suggest, using a discount rate; use the same method to assess the impact of C stock changes.

3) Do not change how GWPs are calculated; assess the impact of C stock changes over an intermediate time period of 20 years, without discounting.

4) Account for all C stock change effects of land use change in the year in which the change takes place

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[151] In reality, the change in C stock happens over several years. But this does not make any difference to the result – at least in systems where the future is not discounted relative to the present.

Option 2 would perhaps be scientifically optimal. But it would put the widely-used IPCC values for GWPs of different greenhouse gases into question, creating inconsistency with other Commission data on climate change. It would have a high data requirement (unlike the other options, it would be necessary to know how C stock changes over time). And there is no consensus on the discount function that should be used. For these reasons, it is not attractive.

In the absence of discounting, it can be argued that option 1 is not attractive because it overvalues the benefits of biofuel use (by giving a significant value to these benefits, even in 100 years' time) relative to the costs of C stock change.

Option 4 would not create a meaningful disincentive to the conversion of high C stock land for biofuel production. Producers could 'take the hit' on a single year's production of biofuel – accepting that they will not find a market for this consignment – and then sell the fuel in future years without reference to the fact that undesirable land conversion had occurred.

Option 3, accounting for C stock change effects of land use change over a 20 year period, without discounting, is therefore the preferred option[152].

In the stakeholder work, there was a consensus that option 3 is acceptable.

I Default values

26. Recommendation: The methodology should include default values.

Reasoning: Without this, the administrative burden of the scheme will be enormous.

27. Recommendation: Where the contribution to overall emissions is small, or where there is limited variation, or the cost or difficulty of establishing actual values is high, these values should be typical of normal production processes.

Reasoning: this rule, derived from the development of a similar scheme in the UK, is appropriate because it takes into account both administrative burdens (through the reference to costs) and the real difference that “actual value” reporting will make (through the reference to the level and variability of the emissions in question).

28. Recommendation: The Commission should make available the details of the calculation of the aggregate default values, including the disaggregated default values for each step of the production process.

Reasoning: This is a precondition for the next recommendation.

29. Recommendation: In assessing greenhouse gas emissions from fuels, fuel suppliers should be able:

a) to *use an actual value;*

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[152] It is sometimes said that a 20 year period is the default value in IPCC rules on this topic. But this is not correct. IPCC lay down a default period of 20 years as an element of the approach to be used in dealing with the problems posed by the fact that the C stock changes happen, in reality, over several years. Thus, this relates to the problem of calculating the size of C stock change. It does not deal with the question of how this stock change should be compared with a flow.

b) to use the aggregate default value for that type of fuel; or

c) to use a value calculated as the sum of actual values for some of the steps of the production process and disaggregated default values for the other steps of the production process.

Reasoning: points a) and b) are a logical consequence of the decision to use default values. Point c) increases the flexibility of the system for fuel suppliers whose performance is generally close to the default value, but is significantly better than the default value on one parameter. These suppliers will be able to use actual values for the parameter on which they have better performance, without being obliged to the additional administrative burden of having to provide actual values for all parameters.

30. Recommendation: When economic operators insert 'actual' values for cultivation activities, replacing default values, they may use either low-level average values or precise values for individual production sites.

Reasoning: regions differ systematically in their requirements for agricultural inputs such as fertiliser. This recommendation permits fuel suppliers to take this into account without the additional administrative burden of having to provide actual values.

J ETBE

31. Recommendation: The greenhouse gas impact of the biofuel component of ETBE should be counted as the same as that of the ethanol used.

Reasoning: the conversion of ethanol into ETBE involves an extra processing step, increasing emissions. However, ETBE substitutes for fuel components which themselves have higher-than-average emissions for energy in their production[153]. Since ETBE production takes place in refineries, it is not possible to quantify either of these effects with certainty.

A neutral approach is therefore recommended.

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[153] Croezen *et al* (2007), ETBE and Ethanol: A comparison of CO2 savings, CE Delft.

8.7.1. Annex 7A

Greenhouse gas savings from biofuel production pathways (assuming no effects due to land use change)

The following values have been calculated using data supplied by the JEC Consortium and according to the methodology recommended in ANNEX 8[154].

biofuel production pathway	greenhouse gas saving (typical)	greenhouse gas saving (default)
sugar beet ethanol	48%	35%
wheat ethanol (process fuel not specified)	21%	0%
wheat ethanol (lignite as process fuel in CHP plant)	21%	0%
wheat ethanol (natural gas as process fuel in conventional boiler)	45%	33%
wheat ethanol (natural gas as process fuel in CHP plant)	54%	45%
wheat ethanol (straw as process fuel in CHP plant)	69%	67%
corn (maize) ethanol, EU produced	56%	49%
sugar cane ethanol	74%	74%
the part from renewable sources of ETBE (ethyl-tertio-butyl-ether)	Equal to that of the ethanol production pathway used	
rape seed biodiesel	44%	36%
sunflower biodiesel	58%	51%
palm oil biodiesel (process not specified)	32%	16%
palm oil biodiesel (process with no methane emissions to air at oil mill)	57%	51%
waste vegetable or animal oil biodiesel	83%	77%
hydrogenated vegetable oil from rape seed	49%	45%
hydrogenated vegetable oil from sunflower	65%	60%
hydrogenated vegetable oil from palm oil (process not specified)	38%	24%
hydrogenated vegetable oil from palm oil (process with no methane emissions to air at oil mill)	63%	60%
pure vegetable oil from rape seed	57%	55%
biogas from municipal organic waste as compressed natural gas	81%	75%
biogas from wet manure as compressed natural gas	86%	83%
biogas from dry manure as compressed natural gas	88%	85%

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[154] See ANNEX 8. For the method used in the calculation of default values, see section 6.3.7.2.2(ii).

8.7.2. Annex 7B

Greenhouse gas savings from biofuel production pathways: comparison of the energy allocation and substitution method for co-products (assuming no effects due to land use change)

biofuel production pathway	greenhouse gas saving		
	Energy allocation	Substitution (co-product to animal feed)	Substitution (co-product to energy)
sugar beet ethanol	48%	32%	65%
wheat ethanol (process fuel not specified)	21%	-20%	0%
wheat ethanol (lignite as process fuel in CHP plant)	21%	-20%	0%
wheat ethanol (natural gas as process fuel in conventional boiler)	45%	20%	40%
wheat ethanol (natural gas as process fuel in CHP plant)	54%	35%	55%
wheat ethanol (straw as process fuel in CHP plant)	69%	61%	81%
corn (maize) ethanol, EU produced (natural gas as process fuel in CHP plant)	56%	34%	67%
sugar cane ethanol	74%		88%
rape seed biodiesel	44%	34%	69%
sunflower biodiesel	58%	58%	86%

palm oil biodiesel (process not specified)	32%	37%	
hydrogenated vegetable oil from rape seed	49%	35%	
hydrogenated vegetable oil from sunflower	65%	59%	
hydrogenated vegetable oil from palm oil (process not specified)	38%	38%	
pure vegetable oil from rape seed	57%	42%	

8.8. Annex 8

Overview of consequences of the biofuel sustainability scheme

1. Farmers

Farmers will benefit from a small rise in prices for agricultural commodities, whether or not they enter the biofuel market. In addition, they will gain an opportunity to sell into this new market.

This will be a premium price market. To sell crops into this market, they will have to fulfil certain conditions:

- They will have to make a record of the geographical location where the crop was produced.

- They will have to state how this land was being used in January 2008 (e.g. arable, set-aside, grassland, forest, wetland).

- If the land was grassland, forest or wetland, and has since been converted to plantation or arable, they will, in most cases, not be able to sell crops from this land into the premium market. However, there will still be an opportunity for them to do so if they can provide additional data showing, for example, that the plant cover in 2003 was significantly below the average for that particular land use.

- For crops from certain types of land (land protected by national nature protection legislation) they will have to provide evidence that the raw material was produced in accordance with good agricultural or forestry management practice.

- For certain types of biofuel (those whose overall greenhouse gas performance is poor – such as sugar beet ethanol), their customers may require additional data – for example, quantities of fertiliser used per ton of crop.

- They will need to ensure that this information is attached (physically or electronically) to the crop consignment at point of sale.

Farmers will be able to mix this crop consignment in containers with other consignments for which such information has not been recorded. In that case, the sustainability information described above will need to be attached to the container along with a record of the total quantity of material in the container and the quantity to which the sustainability information applies. Farmers will be able to withdraw material from the container and sell it indiscriminately either in the normal market or in the premium market. They will be required (under contractual arrangements with their customers) to keep the record updated as they do so. They will be required to ensure that the quantity they sell in the premium market does not exceed the quantity to which the sustainability information applies.

Farmers will be subject to periodic auditing of these arrangements.

Operators of sustainability certification schemes will be able to apply for accreditation via comitology. Such schemes will be obliged to offer a standardised system for recording and transmitting the above information and to undertake periodic auditing of those who use these systems. Farmers will be able to choose to use these schemes. In addition, their customers may make farmers' use of these schemes a condition for access to the premium market.

2. Importers/traders in agricultural commodities

Traders will be required to ensure that the sustainability information described in section 1 remains attached to the consignment during transport and storage.

For types of biofuel with poor overall greenhouse gas performance, traders' customers may require the inclusion of additional data – for example, on transport distances by mode.

Like farmers, traders will be able to mix the consignment to which the sustainability information applies with other consignments, following the rules set out in section 1.

Like farmers, traders will have the option of using the information systems operated by accredited certification schemes (imposing their use on the farmers who supply them). Like farmers, they may have the use of these schemes imposed on them by their own customers.

3. Fuel producers/suppliers

EU fuel suppliers are required to transmit data to Member States on the quantities and types of fuel they sell (including biofuels). This is used for excise duty purposes.

In the case of biofuels, when they transmit these data, they will have to add the sustainability information described above.

In the case of biofuels of a type with poor overall greenhouse gas performance, if fuel suppliers wish to benefit from a support scheme they will need to assess how the production chain can be improved in order to fulfil the minimum greenhouse gas requirement in the directive. They could set minimum standards for their suppliers (in relation, for example, to transport energy use or fertiliser use), and ask for these data to be included in the sustainability information. Or they could optimise their own practices (for example, the types and quantities of fuel used in the production process) and add these data, themselves, to the sustainability information.

Like traders, fuel suppliers will have the option of using the information systems operated by accredited certification schemes (imposing the use of these schemes on their own suppliers).

Fuel suppliers will be held responsible, either by Member States or by the operators of certification schemes, for ensuring the accuracy, reliability and fraud-resistance of the sustainability information.

4. Member States

Member States will be obliged not to give tax exemptions for biofuels that do not fulfil the sustainability criteria; not to count these biofuels towards their national targets; not to allow fuel suppliers to count these biofuels towards their biofuel obligations; and not to allow fuel suppliers to count these biofuels towards any greenhouse gas requirements that may be imposed on the suppliers through revision of the Fuel Quality directive.

By default, Member States will be the bodies responsible for ensuring that the sustainability information provided by fuel suppliers for these purposes is correct.

However, if this information is provided in the form of certificates issued by accredited certification schemes, Member States will be obliged to consider the information as correct. They will not be required to check it.

5. Firms in the food industry

Some firms in the food industry will experience a small rise in the price of some of the inputs they use.

Many of these commodities (such as vegetable oils and sugar) are already traded in a single global market. The markets for the other affected commodities (such as cereals) are expected to become less protected. Thus, European firms will generally be exposed to the same price changes as their competitors.

8.9. Annex 9.

Administrative costs arising from provisions in the directive proposal on the promotion of renewable energy sources.

Proposal for a Directive of the European Parliament and the Council concerning the promotion of renewable energy sources Administrative costs						Tariff (€ per hour)		Time (hour)		Price (per action or equip)	Freq (per year)	Nbr of entities	Total nbr of actions	Total cost	Regulatory origin (%)			
No.	Ass. Art.		Type of obligation	Description of required action(s)	Target group	i	e	i	e						Int	EU	Nat	Reg
1	§18		Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	Member States	65		300,00		19.500,0	0,50	27	14	263.250		100%		
2	§7		Registration	Producing new data	Member States					650.000,0	1,00	28	28	18.200.000		100%		
3	§7		Registration	Retrieving relevant information from existing data	Member States					400.000,0	1,00	28	28	11.200.000		100%		
4	§7		Certification of products or processes	Producing new data	Operators					2.000,0	0,20	15.000	2.000	4.000.000		50%	50%	
5	§11		Other	Familiarising with the information obligation	Member States	200		5.000,00		1.000.000,0	1,00	27	27	27.000.000		25%	75%	
6	§14		Certification of products or processes	Producing new data	Operators	200		20,00		4.000,0	1,00	2.400	2.400	9.600.000		100%		
7	§14		Certification of products or processes	Filling forms and tables	Operators	65		1,00		65,0	94,00	2.400	225.600	14.664.000		100%		
8	§14		Submission of (recurring) reports	Inspecting and checking (including assistance to inspection by public authorities)	Operators	200		20,00		4.000,0	1,00	10.000	10.000	40.000.000		100%		
9	§12		Submission of (recurring) reports	Other	Member States	65		200,00		13.000,0	1,00	27	27	351.000		100%		
10	§7		Application for subsidy or grant	Filling forms and tables	Operators	600		12,00		21.000,0	1,00	1.800	1.800	37.800.000			100%	

8.10. Annex 10

Air pollution control costs by Member State for the various options in 2020 compared to the baseline

Air pollution control costs by Member State (million € in 2020) for controlling SO2, NOX, PM 2.5, VOC and NH3

	Baseline ($61/barrel of oil)	Efficiency	Efficiency with JI/CDM a €30/t CO2	GDP Modulated targets RES and Non ETS + full RES transfer + no access to CDM	GDP Modulated targets RES and Non ETS + no RES transfer + no access to CDM
Austria	1781	1580	1624	1496	1458
Belgium	1840	1645	1671	1631	1614
Bulgaria	1328	1029	1054	1061	1116
Cyprus	178	160	163	164	163
Czech Rep.	1894	1572	1621	1699	1719
Denmark	1334	1187	1212	1125	1140
Estonia	279	225	237	246	248
Finland	1054	911	928	957	984
France	9757	8878	9064	8856	8995
Germany	14943	13469	13789	13640	13558
Greece	2839	2239	2364	2314	2310
Hungary	1121	935	953	1001	989
Ireland	747	612	645	586	589
Italy	9799	8817	8979	7916	7969
Latvia	461	431	443	408	394
Lithuania	466	426	436	466	457
Luxembourg	358	307	315	259	260
Malta	151	130	137	139	138
Netherlands	2915	2544	2587	2492	2505
Poland	7972	6967	7157	7602	7699
Portugal	1623	1365	1460	1548	1555
Romania	2513	2110	2170	2258	2260
Slovakia	559	476	494	498	499
Slovenia	408	316	333	286	294
Spain	9161	8028	8478	7309	7118
Sweden	1624	1406	1445	1262	1275
UK	5558	4663	4768	4678	4530
EU-27	82662	72428	74525	71895	71835

Source: GAINS (2008)

8.11. Annex 11

Reduction in oil and gas imports (€bn) by member state in 2020

	Cost-Efficient GHG and RES targets	As 1 with access JI/CDM at 30€/tCO2	GDP modulated targets RES and Non ETS + full RES transferability	GDP modulated targets RES and Non ETS + full RES transferability + access to CDM at 30/€ t CO2	GDP Modulated targets RES and Non ETS + No RES transfer + no access to CDM
EU27	€ 48,747	€ 44,989	€ 47,223	€ 45,921	€ 40,664
Austria	€ 1,742	€ 1,650	€ 2,067	€ 1,569	€ 1,663
Belgium	€ 1,331	€ 1,126	€ 1,368	€ 1,361	€ 1,135
Bulgaria	€ 407	€ 442	€ 145	€ 33	€ 179
Cyprus	€ 159	€ 128	€ 133	€ 148	€ 123
Czech Rep.	€ 581	€ 519	€ 54	-€ 102	€ 89
Denmark	€ 208	€ 146	€ 347	€ 426	€ 149
Estonia	€ 103	€ 99	€ 33	-€ 16	€ 64
Finland	€ 1,003	€ 1,015	€ 856	€ 797	€ 940
France	€ 7,058	€ 6,300	€ 6,865	€ 7,982	€ 6,356
Germany	€ 8,434	€ 8,031	€ 6,661	€ 7,672	€ 7,292
Greece	€ 778	€ 806	€ 590	€ 443	€ 786
Hungary	€ 1,159	€ 1,149	€ 845	€ 424	€ 935
Ireland	€ 586	€ 516	€ 689	€ 671	€ 520
Italy	€ 7,607	€ 6,581	€ 12,031	€ 12,269	€ 6,739
Latvia	€ 400	€ 394	€ 493	€ 321	€ 403
Lithuania	€ 504	€ 479	€ 378	€ 138	€ 398
Luxembourg	€ 253	€ 202	€ 420	€ 428	€ 204
Malta	€ 52	€ 29	€ 43	€ 54	€ 24
Netherlands	€ 1,856	€ 1,852	€ 1,826	€ 1,907	€ 1,852

Poland	€ 1,344	€ 1,170	€ 170	-€ 278	€ 346
Portugal	€ 1,152	€ 1,140	€ 711	€ 536	€ 703
Romania	€ 710	€ 628	€ 285	€ 285	€ 269
Slovakia	€ 641	€ 565	€ 367	€ 214	€ 373
Slovenia	€ 211	€ 209	€ 275	€ 258	€ 213
Spain	€ 5,233	€ 5,520	€ 6,248	€ 4,161	€ 5,566
Sweden	€ 783	€ 712	€ 1,231	€ 1,263	€ 725
UK	€ 4,452	€ 3,579	€ 2,091	€ 2,955	€ 2,619