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Consistency of policy instruments

How the EU could move to a -30% greenhouse gas reduction target

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IS THERE A CASE FOR THE EU MOVING BEYOND 20% GHG EMISSIONS REDUCTION TARGET BY 2020?

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1 Introduction

This report provides options for how to achieve a 30% reduction in greenhouse gas emissions, in the EU, from 1990 to 2020. The EU has agreed a set of goals (objectives) and related instruments for 2020. The most significant objectives are the 20% or 30% reduction of greenhouse gases (all emissions, both within and outside the Emissions Trading System), the 20% improvement of energy efficiency and the 20% of renewable energy use by 2020. The stringency of the instruments used to reach these goals, must be set carefully to ensure overall consistency. Particularly after the economic crisis of 2008/2009, the Climate and Energy Package has to be "tuned" again to be fully consistent, e.g. fast take up of renewable energy and fewer emissions due to the recession may cause an over-allocation in the EU-ETS.

The EU has a range of targets and policies in place that either directly tackle climate change or have significant climate change co-benefits. How these targets and policies relate to different sectors of the EU economy is summarised in Figure 1.

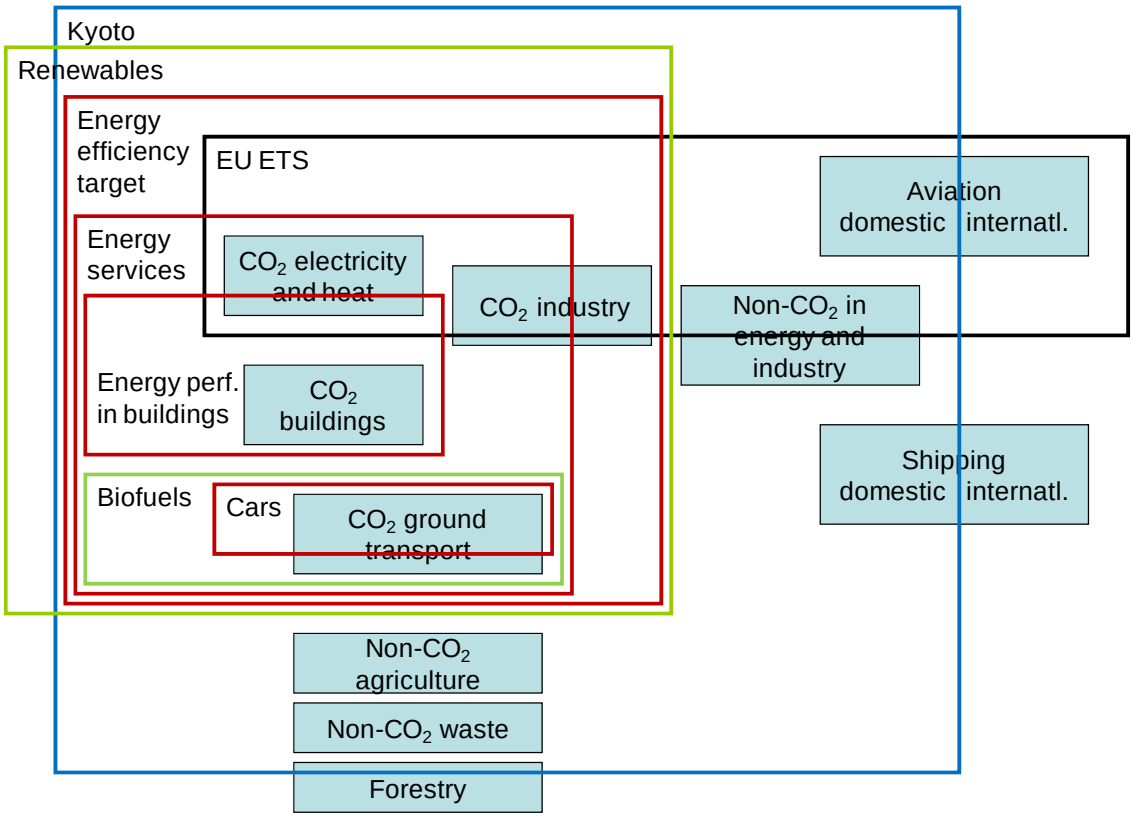

Figure 1 Overlap of EU targets and policies. The blue shaded boxes represent emissions sectors. The coloured squares encompass the sectors (or parts of sectors) which are included in the scope of a particular target.[1]

[1] Some sectors (boxes) are only treated in part by a target or policy. In such cases the lines go through a box.

The figure shows that there is an overlap among the targets and emissions from some sectors are covered by a number of targets. For example, some emissions from industry are covered by the EU ETS, renewables, energy efficiency and Kyoto Protocol targets. The targets are briefly described in the following sections (see also Wesselink et al. 2010)

1.1 The greenhouse gas target

The European Council Conclusions, in March 2007 (European Commission 2007b) agreed that the EU and its Member States should propose a 30% reduction in GHG emissions, by developed countries, by 2020. This was part of a wider international agreement intended to limit global climate change to 2ºC above pre-industrial levels. Until an international agreement is concluded, the EU should make a firm, independent commitment to achieve at least a 20% reduction of GHG emissions by 2020 compared to 1990.

The EU submitted to the Copenhagen Accord a reduction of 20%/30% below 1990 in 2020 and stated that: 'As part of a global and comprehensive agreement for the period beyond 2012, the EU reiterates its conditional offer to move to a 30% reduction by 2020 compared to 1990 levels, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.'[2]

Several Directives support the implementation of the greenhouse gas target. The EU Emissions Trading System covers roughly half of the GHG emissions of the Union and the "effort sharing" Decision (European Commission 2009a) defines targets for Member States for the remaining emissions.

1.2 The renewable energy target

The EU aims to reach a renewable energy target of 20% of renewable energy sources, in gross inland consumption, by 2020 (European Commission 2006b, European Commission 2007a). Within the Climate and Energy Package of 2008 (CEP), the effort made to reach this target was shared between Member States and individual renewable energy share targets were assigned to each. There is also a binding target for *each* Member State to achieve a 10% share by energy content, of biofuels, in petrol and diesel by 2020, subject to certain sustainability criteria.

The targets can be achieved through different combinations of renewable deployment in the electricity, heat and transport sectors. It is within Member State discretion, how they achieve these targets with the available policy instruments of their choice (Held et al. 2010).

1.3 The energy efficiency target

The 2005 Green Paper on energy efficiency (European Commission 2005) outlines the EU's ambition to reduce energy consumption by 20%, compared to Business as Usual

[2] http://unfccc.int/files/meetings/application/pdf/europeanunioncphaccord_app1.pdf

(BAU) projections for 2020, on a cost-effective basis. The projections for the EU at that time were, 1900 million tonne of oil equivalent (Mtoe) gross inland consumption in 2020, compared with 1725 Mtoe energy consumption in 2005.

The 2006 Action Plan for energy efficiency (European Commission 2006a) is more concrete. It outlines a framework of policies and measures for realising the energy savings potential, estimated to be over 20% of EU annual primary energy consumption by 2020. Although the green paper includes gross energy consumption or total consumption, the Action Plan is based on primary energy consumption. Therefore, the most significant difference to the Green Paper is that, gross energy consumption covers only final energy consumed, i.e. does not cover potential energy efficiency improvements in the conversion of primary energy to final energy (e.g. electricity generation).

The Action Plan was endorsed at the Spring Council of 2007, reconfirmed as part of the EU's Climate and Energy Package in 2008/2009 and was finally adopted by the European Heads of State and Government (the European Council) on 17 June 2010 as part of the new 'Europe 2020' strategy. The energy efficiency target was again confirmed at the transport, telecommunications and energy council meeting on 28 February 2011.

Although the baseline of energy consumption has changed due to the recession, we assume, for the purpose of this study, that the target is to maintain energy consumption below 1600 Mtoe in 2020.

The energy efficiency target is not binding and is currently specified for each sector. According to a Communication from the European Commission in November 2010 the, '…. Energy Efficiency Plan to be presented in early 2011… [will] be followed by concrete regulatory proposals in the course of that year. It will also address the issue of financing in terms of access to finance, the availability of innovative financing products, incentives to induce energy-efficiency investments as well as the role of EU funding, in particular the structural funds, further building on existing successful examples' (European Commission 2010b).

The energy efficiency target can be met through cost-effective measures in combination with the implementation of the renewables target (Wesselink et al. 2010) leading to a net societal economic gain.

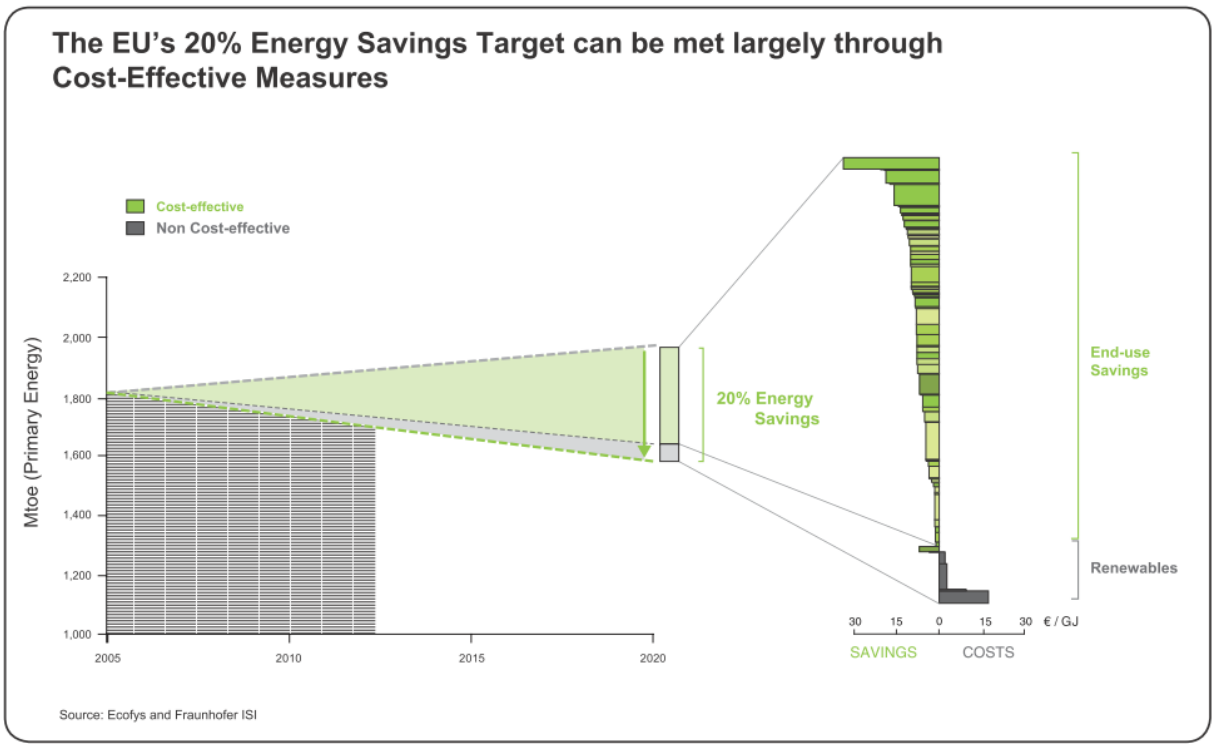

Figure 1: Meeting EU 20% target in a cost effective manner (Wesselink et al. 2010 p. 6)

The energy efficiency target is not directly linked to the EU's current legislative policy package. However, the combined directives described below, are still intended to contribute to increasing the energy efficiency of the EU.

1.3.1 The Energy Services Directive

The Directive on energy end-use and energy services (Directive 2006/32/EC, hereafter Energy Services Directive) applies to energy providers and final energy consumers, excluding final energy consumers that participate in the EU-ETS (industry). Therefore, the Directive covers the fuel, district heat and electricity consumption in sectors such as the built environment, transport and smaller industrial installations.

The Directive aims to promote the efficient endues of energy. The target is a volume of energy savings equal to 9% of the final energy use of a reference period, 2000 to 2005, for 2016. EU Member States must present National Energy Efficiency Action Plans (NEEAPs) for their progress to be monitored.

1.3.2 The Energy Performance in Buildings Directive

The Energy Performance and Buildings Directive, (EPBD), has recently been recast (Directive 2010/31/EU). Energy performance standards for buildings are the key element of the Directive. Member States will ensure that minimum energy performance requirements for buildings are set at cost-optimal levels. From 2019 onwards, public

authorities that occupy and own a new building will ensure that the building is a 'nearly zero energy' building. By 2021, all new buildings, including those privately owned, will be 'nearly zero energy' buildings. (European Parliament and European Council 2010)

1.3.3 Agreement on emissions from passenger cars

The EU's strategy to improve fuel economy and reduce CO_2 emissions from passenger cars has evolved over the years. First, negotiated self-commitments were concluded with the European Automobile Manufacturers' Association (ACEA), the Japanese Automobile Manufacturers' Association (JAMA) and the Korean Automobile Manufacturers' Association (KAMA) in 1999/2000. The three commitments contained the same quantified CO_2 emission objective for the new passenger cars sold in the European Union, i.e. 140 grams carbon dioxide per kilometre (gCO_2/km) (to be achieved by 2009 by JAMA and KAMA, and by 2008 by ACEA). At that time, the EU's strategy to reduce CO_2 emissions from passenger cars included a long-term target for passenger cars newly registered from 1 January 2012 in the Community, of 120 gCO_2/km.

Because the targets set in the voluntary agreement were missed, the regulation setting CO_2 standards for passenger cars (Regulation No 443/2009, European Council and European Parliament 2009) was introduced. The regulation stipulates 130 gCO_2/km for the new passenger car fleet entering the market, to be achieved by 2015, by improving vehicle motor technology. In addition to improved motor technology, complementary measures such as low carbon fuels, co-driving and improved tyres, will also contribute to achieving the Community objective of 120 gCO_2/km. A review of the Regulation (to be completed by 2013) will define,

'…the modalities for reaching, by the year 2020, a long-term target of 95 gCO_2/km in a cost-effective manner; and the aspects of the implementation of that target…'(European Council and European Parliament 2009)

This indicates that the significance of improved motor technology compared to complementary measures, in achieving the 95 gCO_2/km target, is still undecided.

Despite these improvements, the voluntary 'ACEA' (European Automobile Manufacturers' Association) target of 140 gCO_2/km, by 2008, was not met. A strong increase in the volume of vehicles over the same time period has also negated the improved car performance, resulting in a 30% increase of CO_2 emissions from road transport over the past two decades (EEA 2009). Although the recent regulatory target of 130 gCO_2/km target (2015) is close to the long-term industry trend, the implementation of a 95 gCO_2/km standard can be regarded as more ambitious.

1.3.4 Other directives related to energy efficiency

The **Eco-design Directive**, revised in 2009 (Directive 2009/125/EC), requires producers to make reductions in energy use and other environmental impacts an integral part of the design process of electrical appliances. An elemental aspect of the directive is the energy efficiency requirements for product groups, which are set through 'implementing measures'. Among the product groups involved are typical household or service

appliances that use electricity or fuel, such as boilers, fridges and computers, and industrial appliances such as electric motors and fans.

The **Energy Labelling Directive** (Council Directive 92/75/EEC) is the framework for implementation of Directives for seven household appliance groups: refrigerators, freezers and combinations, washing machines, dryers, dishwashing machines, electrical ovens, lighting, and air-conditioning units. All appliances should be provided with an energy label and an information pack when offered for sale or hire, to provide the consumer with information on the energy demand of the appliance.

The Directive, 'on the promotion of cogeneration based on a useful heat demand' (2004/8/EC, hereafter **CHP Directive**) is intended to stimulate energy savings and the improvement of energy security. The Directive sets definitions for high-efficiency CHP (HECHP) and obliges Member States to:

i. identify their HE-CHP potentials
ii. ensure that support for CHP is based on the demand for useful heat
iii. to reduce the barriers for CHP regarding grid access, tariffs and administrative procedures
iv. to set up a system for guarantees of origin for HE-CHP

Many of the CHP installations addressed by the Directive are covered by the EU-ETS. The CHP Directive is different from most of the Directives discussed here, as it is a technology -specific Directive.

2 Method and discussion

This chapter describes and discusses the method of the analysis. First, we created a common dataset of activity data, energy and emissions, for the EU 27, from 1990 to 2020 and then calculated several illustrative cases on how to reach the 30% goal.

We initially developed one complete dataset of activity data, energy use and emissions (historic and baseline projections) for the EU 27, from 1990 to 2020 (see Figure 2 and Figure 3). The sources of this data include:

- Historic and future energy data of the baseline from PRIMES which form the basis for energy related projections of emissions (2010, post recession)
- GHG emissions inventories of EU Member States (latest 2010 CRF submissions, UNFCCC 2010c)
- Projections of non-energy GHG emissions from the 5th National Communication (UNFCCC 2010b)

Using this methodology, baseline emissions, excluding LULUCF and international transport (Kyoto emissions), are 12% below the 1990 level in 2020 (Figure 2) and BAU emissions across all sectors are 3% below 1990 (Figure 3). Assumed 2010 emissions are 12% below 1990. These figures incorporate latest policies and the effect of the recession from the PRIMES baseline scenario. They are in total slightly different to the original PRIMES data due to a mix of different data sources. The latest estimate made by the European Environment Agency, that emissions in 2009 were historically low at 17.3% below 1990 (EEA 2010), has not been considered in this report. Emissions are expected to have increased in 2010.

For our analysis and throughout this report we have assumed that the 20% and 30% greenhouse gas targets exclude emissions from international transport. The EU's submission to the Copenhagen Accord and the agreement of the Climate and Energy Package does not specify this. But because the usual accounting method under the Kyoto Protocol *excludes* international transport, we assumed it to be excluded. International aviation is, however, included in the EU ETS as of 2012. The EU's 20% target is implemented by a legally-binding target for the ETS and a separate legally-binding target for the Non-ETS sectors (European Commission 2010a), both of which approximately add up to a 20% reduction below 1990. UK DECC estimates that '…the inclusion of international aviation adds around a 1.2 -1.4 % point reduction for the rest of the economy (compared to the 1990 target). So including aviation means the other sectors need to reduce 21.2% to 21.4% instead of 20%' (Marks 2011).

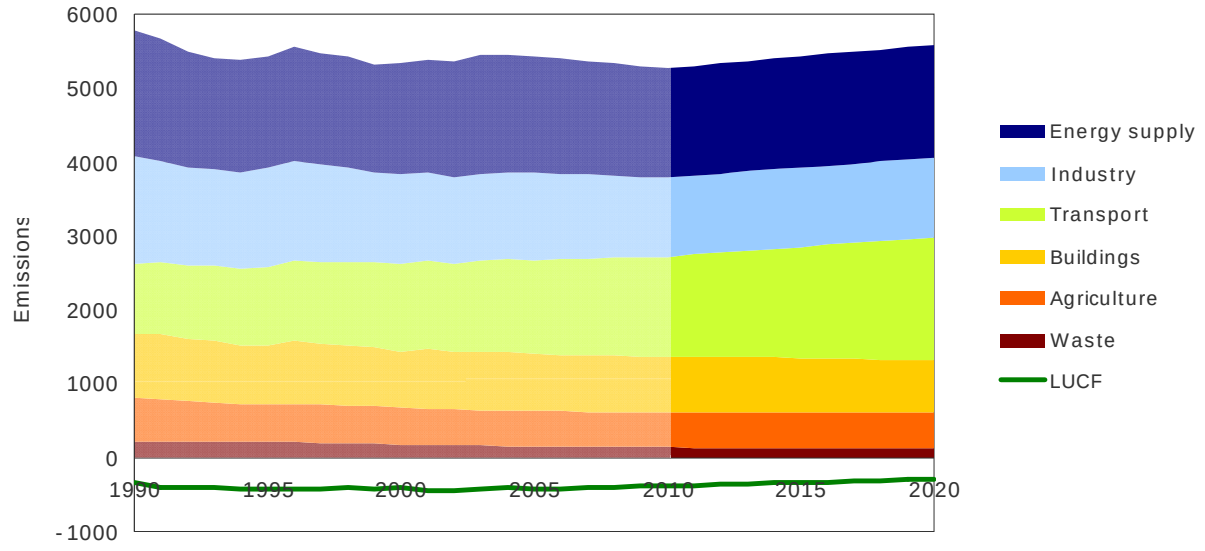

Figure 2 Historic and baseline emissions per sector in the EU 27 (all sectors, including also international transport) as compiled for this report

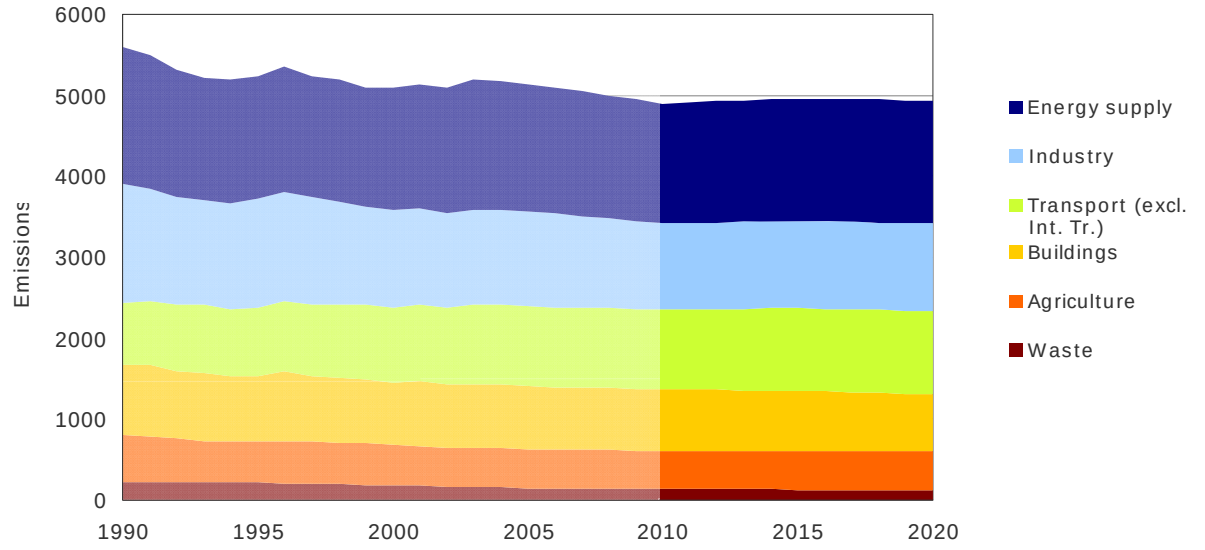

Figure 3 Historic and baseline emissions per sector in the EU 27 (excl. LUCF, excl. int. transport) as compiled for this report

Depending on the underlying rationales, there could be different ways to reach the 30% reduction target. Different possible reinforcing or contradicting objectives include:

- **Short- to mid-term cost minimisation**: The focus would be on those areas where emissions can be reduced at the least cost, e.g. energy efficiency or through offsets from outside of the EU.
- **Long-term cost minimisation / technological learning:** From a long-term perspective, activities would be encouraged in sectors where infrastructure has a long lifetime. There is also focus on areas where emission reduction costs are currently high, so that mitigation options become available in the long-term.
- **Energy security improvement:** The focus would be on reducing the dependence on insecure energy sources, e.g. gas imports from only a small number of suppliers or oil imports from politically unstable regions.
- **Low carbon growth promotion:** The focus would be on areas where reducing GHG emissions could have the most significant benefits for long-term low carbon economic growth, by stimulating innovation and new business areas from domestic and export markets.
- **Equity considerations:** The focus would be on avoiding severe impacts on some Member States (MS) or different groups in society.

With these objectives in mind, we analysed five illustrative options that resulted in different sector splits, achieving a 20% or 30% reduction. The first two options are based on EU legislation/proposals and the latter three are cases based on our own calculations:

- **Climate and Energy Package:** The CEP includes an EU-wide 20% emission reduction target, split among the ETS (-21% below 2005) and non-ETS (-10% below 2005) sectors.
- **EU Commission communication:** The EU Commission provides two estimates for possible distributions of reduction efforts under a more stringent 30% reduction target, by 2020: 30% reduction with flexibility, (policy target scenario with 25% domestic reduction and 5% credit-use) and 30% domestic reduction, (all additional reduction efforts are reached domestically). The spilt between sectors was based on modelling the least-cost reductions.
- **Least-cost reductions:** In this approach, emission reductions across the EU are shared so that the most cost effective measures are chosen first. Using a Marginal Abatement Cost Curve (MACC), it is supposed that reduction measures are implemented in the order of their costs, starting with the least-cost options, until a 30% emission reduction is reached across the entire EU. The approach represents the most cost-effective (short to mid-term) emission reductions in 2020, for the EU.
- **EE and RES targets first:** In this situation, the renewable energy target would be implemented first, followed by the energy efficiency target. Realistic emission reductions are then assumed for the remaining sectors not covered by these two

targets. Because the approach looks at currently existing EU targets, it represents a politically viable means for EU implementation.

- **Offsets and LULUCF:** For illustrative purposes we will first include a case where LULUCF accounting and maximum use of offsets would require less reduction efforts in the other EU sectors. If possible this case will include no change to the current ETS cap. The goal of this approach is to minimise the domestic emission reduction efforts in achieving the 30% target.

Each option adheres to different underlying priorities, but a few patterns can be observed:

- Approaches are either, optimising short-term costs (through e.g. offsetting or least cost emission reductions) or taking a long-term perspective. Most examined the options focus on short-term costs, including the proposal in the Commission's communication on the split between sectors under the 30% target. Only the 'EE and RES targets first' explicitly regard long-term cost reductions and technological learning by addressing RE directly.
- 'Energy security' as a priority applies to all approaches that effectively lead to domestic emission reductions, as both renewable energy and energy efficiency contributes. Approaches that rely more on offsetting contribute less to energy security.
- 'Promote low carbon growth' could also be applied to all of these approaches, but this heavily depends on the implementation, and requires additional policy objectives for long-term cost reductions, e.g. for R&D.
- 'Equity considerations' are relevant to all approaches, but depend on the details of implementation.

Approaches that optimise the short-term costs can create unwanted consequences:

- A number of sectors may build infrastructure to meet short-term targets, resulting in stranded assets in the long-term. For example, gas generation may be built as a short-term abatement option but may increase the cost of longer-term decarbonisation.
- The cost of zero carbon (rather than low carbon) infrastructure may not fall significantly over time due to insufficient short-term investment and deployment of these technologies is also currently more expensive.

Some approaches might result in a more proactive development of low carbon technologies, which would then result in the promotion of low carbon technology export sectors. It is conceivable that an approach that explicitly targets energy efficiency might promote low carbon technologies better than a broad setup approach. However, such an evaluation is beyond the scope of this paper and further analysis is necessary to make quantitative judgements.

Table 2 provides an overview of the options for sharing emissions in relation to the options with or without offsets. In total, we have considered eight cases.

	Target 20% with offsets (~15% domestic)	Target 30% with offsets and LULUCF (~20% to 25% domestic)	Target 30% without offsets and LULUCF (30% domestic)
Current Climate and Energy Package (CEP)	X		
EU Commission Communication		X	X
Least cost approach	X	X	X
EE and RES targets First			X
Offsets and LULUCF		X	

Table 1 Analysis of different cases

The current Climate and Energy Package is specifically intended to achieve 20% reductions, but does allow for some offsets. The EU Commission Communication includes two cases, one with and one without offsets. The "least-cost approach" will be calculated for this 20% case and also for reaching the 30% target with and without offsets and LULUCF. The "EE and RES targets first" case is only calculated for reaching the target "without LULUCF and offsets", because implementation of the renewable energy and energy efficiency targets would already reduce domestic emissions by more than 20%. The "Offsets and LULUCF" case will be calculated for the "30% target with offsets" case only.

For all cases we discuss whether the resulting development of domestic emissions is consistent with what would be necessary for achieving an 80% to 95% reduction by 2050.

3 Climate and Energy Package (CEP) for 20% emission reduction target

In 2008, the EU adopted its Climate and Energy Package (CEP). This sets reduction targets for emissions, and targets to increase energy efficiency and renewables, by 2020. These targets will become the basis for the realisation of an overall emission reduction of approximately 20% below 1990 levels, by 2020.

The overall 20% emission reduction target is split between the ETS and non-ETS sectors as follows:

- -21% below 2005 verified emissions for ETS sectors
- -10% below 2005 emissions for non-ETS sectors

Resulting sector reductions are provided in Figure 12 and Figure 13.

4 EU Commission Communication on 30% emission reduction

The EU Commission provides two estimates for possible distributions of reduction efforts under a more stringent 30% reduction target for 2020 (European Commission 2010a, see also Table 2):

- 30% reduction with flexibility – policy target scenario with 25% domestic reduction and 5% credit-use
- 30% domestic reduction - all additional reduction efforts are reached domestically; scenario to identify the economically optimal distribution of efforts between ETS and non-ETS

2020 emission reductions [% reduction below 2005]	**~ 20% target (reference)**	**30% with flexibility (25% domestic)**	**30% domestic**
% GHG reduction compared to 2005	-14%	-19%	-24%
% reduction ETS compared to 2005	-19%	-26%	-34%
% reduction non-ETS compared to 2005	-9.5%	-13%	-16%

Table 2 Emission reductions in 2020 compared to 2005 under different assumptions as given in the EU communication (European Commission 2010a)

The split is based on a model study, assuming least-cost reductions across all sectors. Both ETS and non-ETS should contribute considerably, however, the cost-effective potential remains lower in the non-ETS sectors, according to the models (see also Figure 12 and Figure 13).

Although the 20% target is decided at a political level, the EU Commission considers the 30% with flexibility scenario, to be the most compatible to a 2°C trajectory.

5 Reaching 30% at the least costs

The 30% target could also be reached by using a least-cost approach across Europe. With such an approach, it is supposed that the overall costs to society are minimised. It reflects an optimal short to mid-term outcome, but neglects long-term issues, such as the learning of RE technologies and a necessary system switch. It also neglects any non-financial barriers not reflected in the cost curve and does not address potential difficulties in obtaining up-front financing for the implementation of the options.

Technically, an approximation of this can be achieved by ranking abatement options by their marginal abatement costs, from low to high. Marginal abatement cost curves (MACC) can then be used to determine the cost of reducing a given amount of emissions and the order of measures executed. From the left side of the curve to the right, all measures are supposed to be taken, until the specified amount of emission reductions is achieved. An illustration of a MACC for Europe is given in Figure 4.

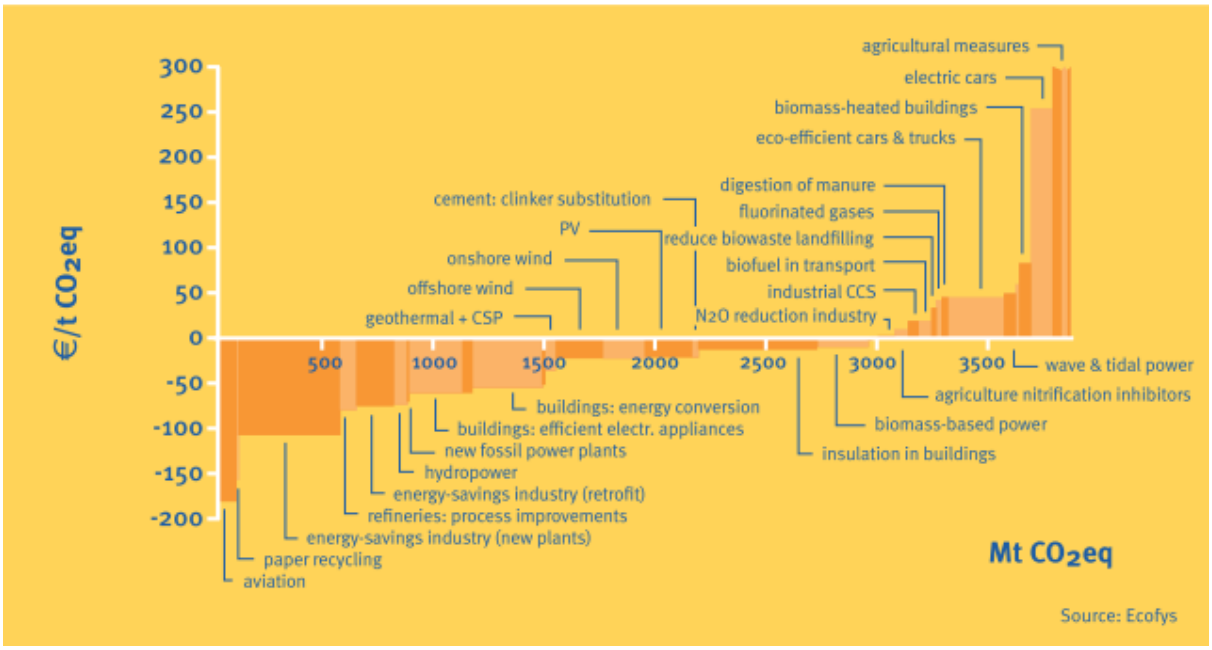

Figure 4 Abatement cost curve for 650 technologies in the EU27 in 2030, aggregated into clusters.

We used the SERPEC MACC (Figure 4) that we updated for this project with a post recession baseline. We determined the total amount of emission reductions achieved per sector (Figure 6). We assumed that all measures will be taken until the target is reached. For the most stringent case, this method only provided reduction options until a 28% emission reduction was achieved, not 30%[3]. All emission reductions were then

[3] This is due to the simplified assumptions made in the update: the baseline was to after recession values using a simple multiplication factor and the the available options were in the MACC were reduced due to the 5 years that passed from 2005 – 2010 by simply mulitplying all options by a factor of 10/15. On the other hand no additional new options were added that could have emerged in the last 5 years.

aggregated at the sector level, including the EU ETS and non EU ETS. For details on the methodology see the Appendix.

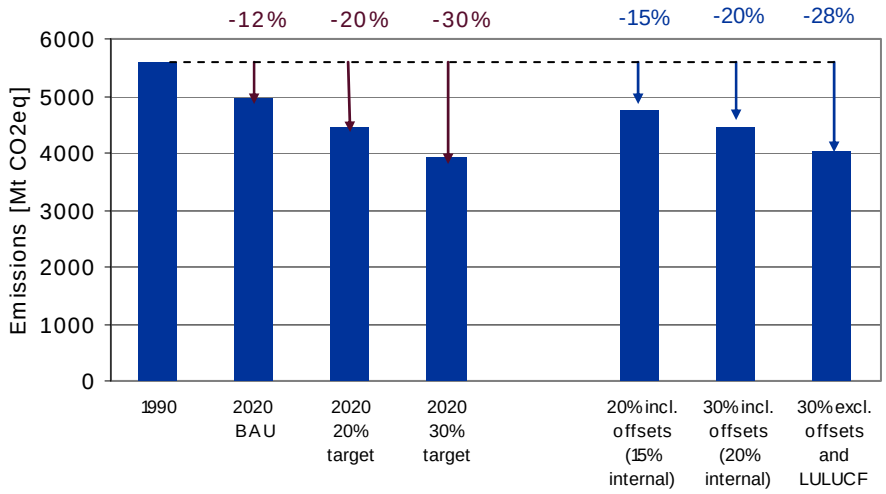

Figure 5 Emission levels under the "30% at least cost" scenario for all sectors and gases covered under the Kyoto Protocol (i.e. excl. LULUCF, excl. international transport). [4]

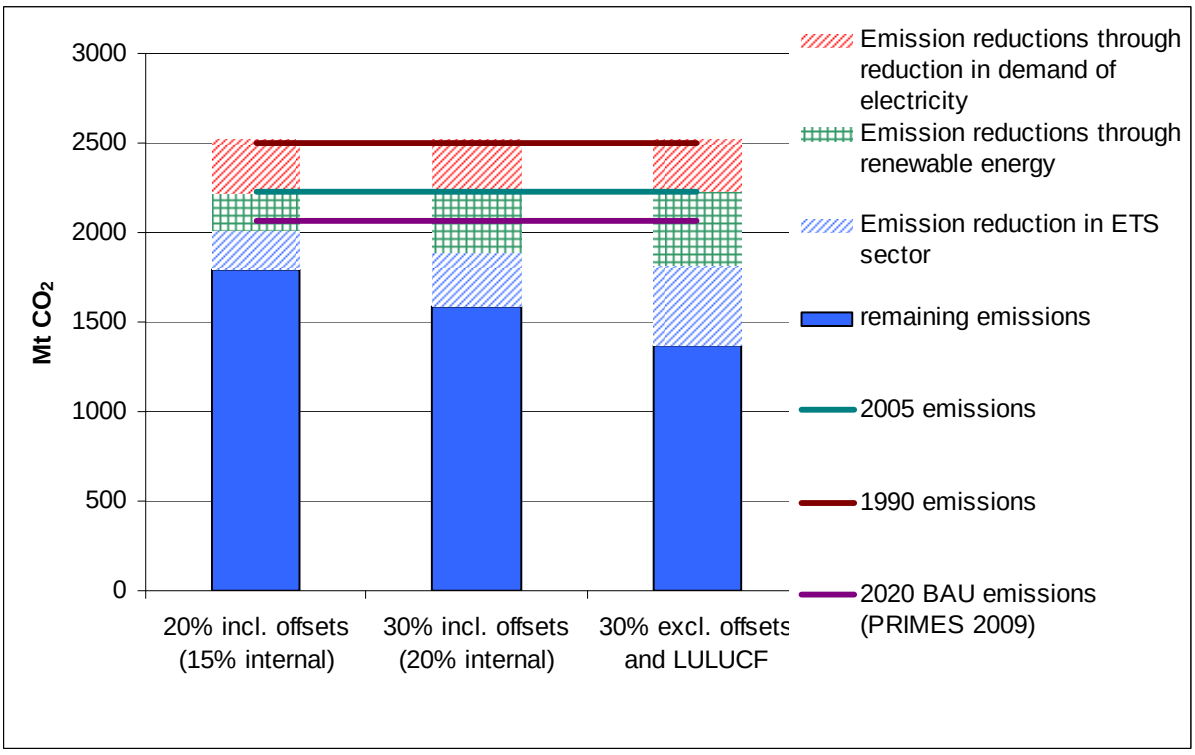

Figure 6 Emission level in the ETS sectors for the three least cost cases and split of emission reduction below the Frozen Technology Reference Line, FTRL. The baseline of this study is shown as straight line.

[4] With the scaling of the MACC as described in the Appendix only a 28% domestic emission reduction can be reached until 2020. It is therefore strictly speaking no longer a least-cost case.

One interesting observation is that emissions covered under the ETS are influenced by reductions of electricity consumption and supply of electricity from renewable sources. Figure 6 shows emission *reductions* split in the ETS sector for each of the least cost scenario cases. Under the -30% domestic reduction case, only 38% of the reductions of emissions covered by the ETS have to be achieved by the industry covered by the ETS directly. 26% of the reductions come from efficiency gains in electricity demand; the burden is on sectors that *consume* electricity. 36% of the reductions are achieved through introduction of renewable energy, which are incentivised through other support mechanisms. This shows that tightening the cap on the ETS, together with energy efficiency and renewable policies, does only in part put an additional burden on the industry covered by the ETS.

6 Reaching 30% consistent with renewable and efficiency targets

This section includes the methodology and results for how to reach a 30% emission reduction target through the implementation of the EU's energy efficiency and renewable targets. We find that after the recession, the full implementation of the energy efficiency target and the renewable target would lead to an emission reduction of approximately 30% domestically.

For this approach it is important to stress the difference between the target as set at the EU level (regarded in this chapter) and the means and policies set at an EU and, particularly, Member State level (not regarded in this chapter). If an appropriate framework, including binding targets and a policy framework, is put in place to reach these targets, the EU can reach its 30% target domestically. Our results do not imply that sufficient action is already being taken to reach the 20% energy efficiency target or the 30% GHG reduction target.

Methodology

As mentioned in the introduction, the EU has not only set a target for GHG emissions but also for renewable energy production (RE target) and energy efficiency (EE target)[5] (see Chapter 1). Although these targets are set independently, they are directly connected to the achievement of the GHG target (see Figure 1).

In an earlier analysis, Ecofys evaluated the interrelation of these three targets (Höhne, 2008 4211 /id}). The result was that "for the EU 27 the combined renewable and energy efficiency target base-case leads to a GHG emission reduction of 26% on 1990 levels by 2020". This analysis was undertaken before the financial crisis and needs to be updated.

We updated this earlier analysis using a post-recession baseline. For this we used the newest PRIMES data available in 2010 for projections of energy use and respective emissions (European Commission 2009b). For non-energy emissions we used the newest emission projections, provided by the EU members states to the UNFCCC (UNFCCC 2010b). We also updated the historical emissions with the newest country submissions to the UNFCCC (UNFCCC 2010c).

The update changed the projected BAU paths, but the historical numbers for 1990 and 2005 remained largely unchanged. Under the new BAU scenario, emissions are already reduced by 12% until the year 2020; under the old scenario this was only 2% (Höhne 2008).

We first, determined the resulting emission level in 2020 under the supposition that only the renewable energy (RE) target will be met. We applied the country specific targets provided in Directive 2009/28/EC, as a percentage of total final energy consumption. To

[5] While the renewable energy target is part of Climate and Energy Package of the EU (CEP) the energy efficiency target is currently not.

split these targets across sectors we assumed that countries would implement a least-cost approach.

We added two cases as sensitivity tests. In the first one, we supposed that the renewable targets are shared among Member States based on a least-cost approach. This could be the resulting situation if Member States make extensive use of the provision to jointly implement their targets. A second case supposes an equal percentage increase of the share of renewables in all sectors and countries.

We then added the energy efficiency (EE) target on top of the RE target (RE + EE). The energy efficiency target sets a 20% reduction in Gross Inland Consumption of Energy compared to the BAU. BAU projections, at the time of the decision on the target for the EU27, were 1900 Mtoe, explicitly mentioned in the Green Paper[6]. Consequently, we supposed the target to be 20% below this value, despite the fact that post-recession BAU projections are now lower (PRIMES: app. 1800 Mtoe).

Here, we supposed that the EE target is fully achieved. However, recent analysis shows that the current policy instruments are not sufficient to achieve this target (Wesselink et al. 2010).

For sharing the 20% reduction in energy use across sectors and countries we applied two approaches: We adopted an equal percentage reduction of energy use across all EU Member States as default. This is a simple, first order method. We added sensitivities as error bars in Figure 7 by using an alternate approach where sector energy efficiencies converge.

Together with the two EE cases we have a total of six cases, of which one, as described above, is selected as the default.

As a final step, we added emission reductions in those sectors that are not covered by the two previous targets, the non-energy emissions. We adopted the emissions changes in the sectors, as provided in Table 3. We also added sensitivities to this approach by using the same five cases under the EE + RE case and added the supposition to each, that reductions in the other sectors will also be achieved.

[6] Green Paper on Energy Efficiency or Doing More With Less COM(2005) 265 final (European Commission 2005)

Non - energy sectors and Efficiency indicators	Necessary values in 2020
Non-energy in industry: Reduce emissions from 2005 by at least	20%
Other energy industries (fugitive emissions): Reduce emissions from 2005 by at least	50%
Non-CO_2 Agriculture: Reduction below BAU in 2020	10%
LUCF: At least do not increase emissions / decrease removals from 2005	
Waste: Converge emissions per capita to [2005 average: 0.31 tCO_2eq/cap]	0.2 tCO_2eq/cap
International transport: Reduction below BAU in 2020 (only relevant where these emissions are included)	30%

Table 3 Assumptions made for non-energy sectors under the "consistency with EE and RE target" scenario, based on mitigation potential

Results

Figure 7 provides a summary of the reductions achieved in the different cases. Our BAU scenario is already 12% below 1990 levels, in 2020. Achieving only the renewables target results in a reduction of approximately 18% (range from 18- 20%) below 1990, in 2020 (excl. LULUCF, excl. international transport). Achieving the renewables and the energy efficiency targets together will result in an approximate 30% GHG reduction by 2020 (range from 28% to 31%). If we suppose an additional reduction in the sectors not covered by these two targets, the reductions will be greater than 30%.

For comparison, the EU Commission calculates that the full implementation of the renewable and the efficiency targets would reduce domestic greenhouse gas emissions "by 25% or more" by 2020 (European Commission 2011, page 55). Differences between the Commission's and our estimate could be a different assumed split of the renewable and energy efficiency target across sectors and a different treatment of international aviation.

In our analysis made before the recession, we calculated that reductions from the energy efficiency target and the renewables target would already result in a 26% reduction below 1990 levels, by 2020. (Höhne et al. 2008).

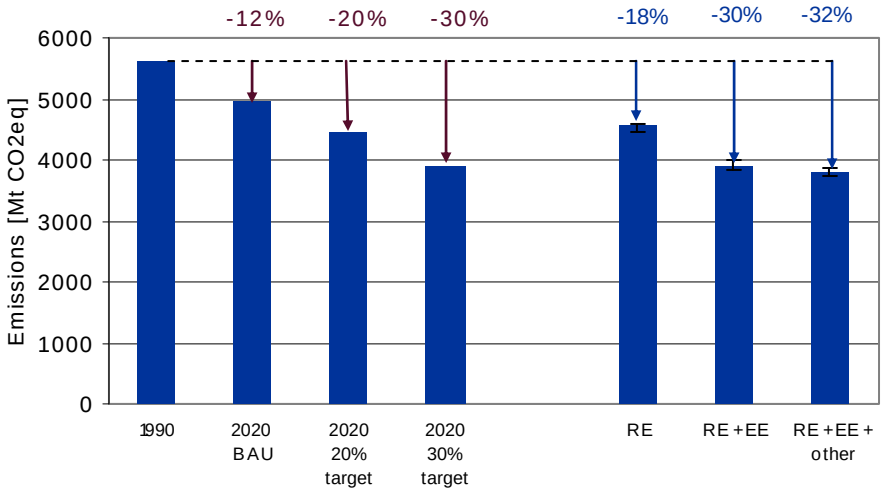

Figure 7 Emission levels under the "consistency with EE and RE target" scenario for all sectors and gases covered under the Kyoto Protocol (i.e. excl. LULUCF, excl. international transport). Error bars show the range from possible alternatives to reach the energy efficiency and renewables targets.

The way the RE targets are shared among the countries does not seem to make a great difference to the emission reductions achieved, illustrated by the the error bars in the picture. A reason for this could be that in our calculation, all Member States will split the effort of the target between the heat, transport and electricity sectors in a similar manner, with the majoriy of the effort made, in the electricity sector.

The split of the emission level by sector as well as the sectoral reduction wedge split illustrates a clear dominance of the emission reductions in the energy industry and industry sector (Figure 8). This is due to the effect that energy efficiency measures for electrical appliances reduce the electricity demand and therefore reduce the emissions covered in the ETS (see also Section 6). This has implications for the EU ETS cap for 2020. Figure 9 shows that the cap needs to be set at 38% below 2005 emission levels (41% below 1990) for this sector, to be consistent with this scenario.

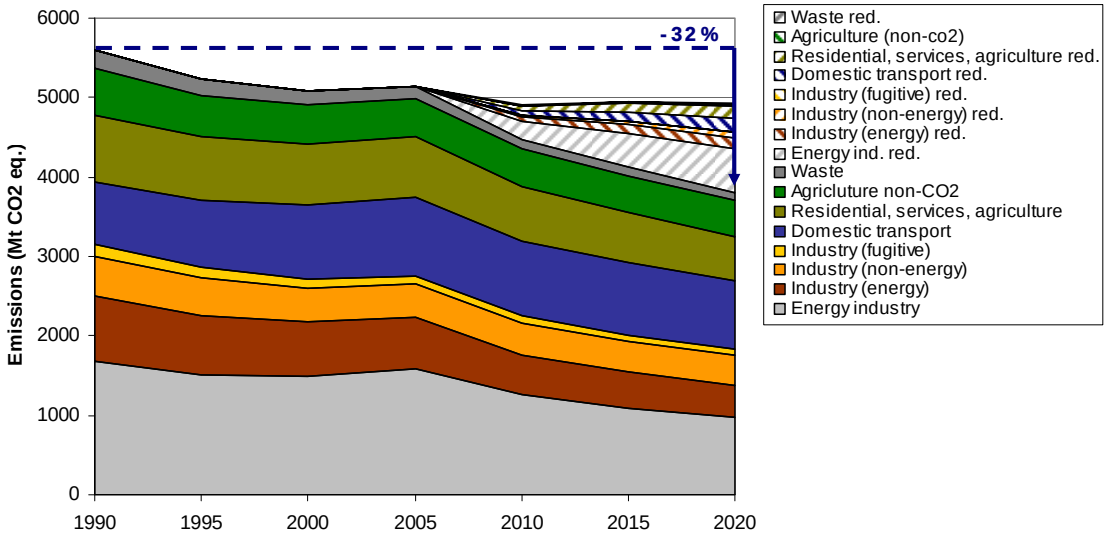

Figure 8 Sectoral emission and reduction split under the "consistency with EE and RE target"

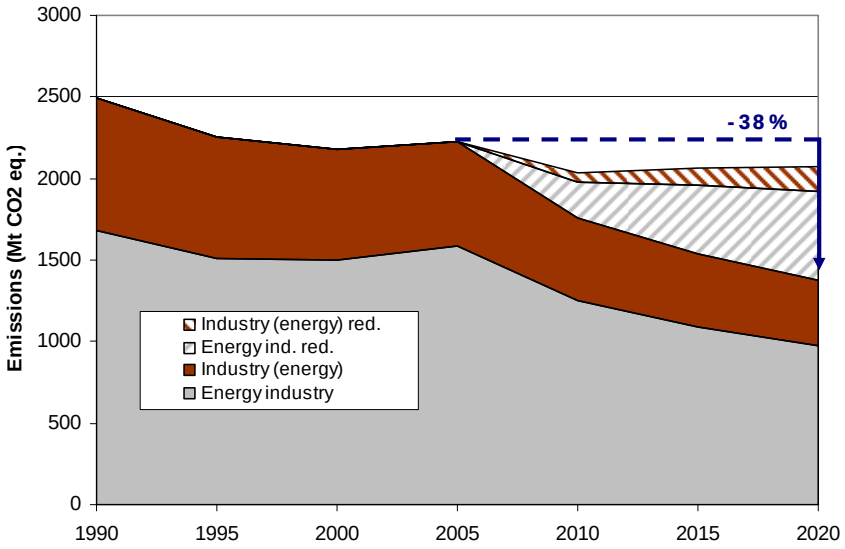

Figure 9 Sectoral emission and reduction split in the Energy industry and industry sectors (ETS) under the "consistency with EE and RE target"

7 Reaching nominal 30% with offsets and LULUCF

Instead of meeting the 30% target entirely with domestic emission reductions, the share of domestic reductions could be reduced by using offsets and applying LULUCF accounting rules.

In this section we will analyse the influence of offsets and LULUCF accounting on the amount of remaining necessary domestic mitigation action in the EU. After evaluating the possible influence of offsets (Chapter 7.1) and LULUCF accounting (Chapter 7.2), we provide an estimate on the remaining necessary domestic action (Chapter 7.3).

7.1 Influence of offsets

The EU legislation sets limits on the amount of offsets used to fulfil its emission reduction targets. Offsets are credits generated by emission reductions outside the EU. With the use of offsets the national emission reduction effort is reduced and, instead, emissions are reduced internationally. In an ideal scenario, i.e. if the emission reductions achieved through offsets are purely additional, the international emission level would remain unchanged.

Different rules exist for the ETS sectors and the non-ETS sectors on how many credits may be used. The EU decisions for the period from 2008 to 2012 include:

- in non-ETS sectors: no limit regarding offsets
- in ETS sectors: countries must indicate their planned offsets, which must be approved by the Commission

To reach its proposed emission reductions of 20% below 1990 levels, the EU decided on the Climate and Energy Package (CEP) in 2008. Regarding credits, the CEP provides the following rules for 2013 to 2020:

- In non-ETS sectors, annual quantity of credits up to 3% of 2005 non-ETS emissions. This can be increased by 1 percentage point in special cases.
- In ETS, installations may use up to 50% offsets, considering their 2008-2020 cap if they are already included in the ETS, considering their 2005 level for new entrants.

The CEP also specifies that in the case of moving to a 30% target, half of the additional effort can be achieved through offsets, but details of this rule yet have to be agreed. This would allow additional 5 percentage points of the efforts to be achieved by with offsets.

These rules, established in the climate package, leave a high degree of uncertainty regarding the actual volume of offsets that will be used. They only describe the potential access to credits and not the actual use. They therefore provide only a maximum limit. Countries or companies may chose to not use offsets at all. The economic downturn during the financial crisis might have reduced the demand of offsets even further (see Appendix III). Even this ‘maximum limit’ cannot be predetermined as there are too many uncertain variables (e.g. the number of new entrants in the ETS or the definition of special cases in the non ETS sector).

For this study, we compared different sources which analyse the amount of offsets available in the EU by 2020 under different reduction targets (see Appendix III). Our reviews of studies finds that about 2 to 4 percentage points of the 20% target are allowed to be achieved through offsets. The remaining domestic action would therefore be 16 to 18% below 1990 emission levels. This range includes the maximum potential. It is uncertain how much of this potential will actually be used.

When moving to a more ambitious 30% target, a larger amount of offsets, up to 7 to 9% from 1990 levels, would be permitted. Moving from a total 20% to a total 30% target would therefore only require domestic action about 5% at the minimum of, not 10%. Domestic emissions would therefore be at 21 to 23% below 1990 levels, by 2020.

For comparison, the EU estimates a maximum limit for offsets of 4% from 1990 emissions for the 20% target and 9% from 1990 emissions for the 30% target (UNFCCC 2010a), which is in line with our review of studies.

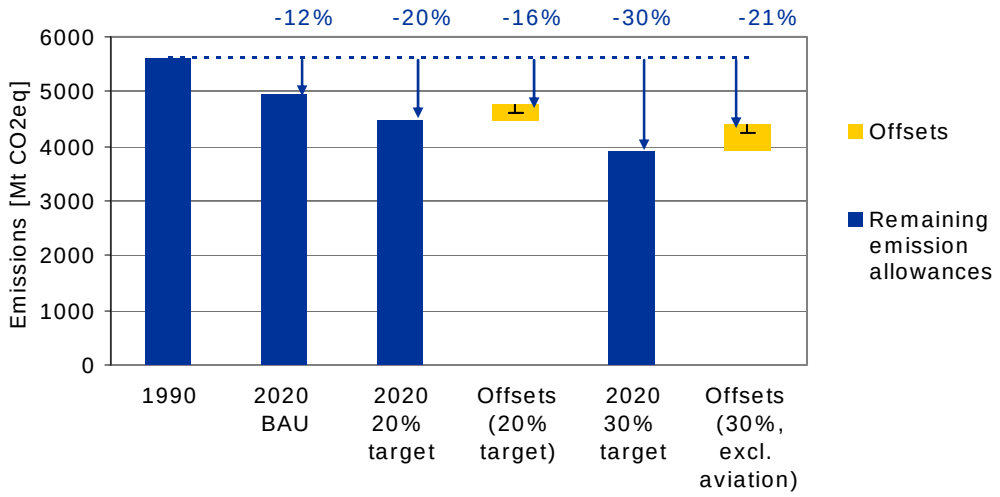

Figure 10 Effect of offsets on the 30% reduction target (excluding aviation)

One major uncertainty, when estimating the additional credits needed to move from the 20% to the 30% target, is the distribution of the additional effort between ETS and non-ETS. In both sectors different shares of usable credits are permitted, which directly affects the total amount of allowed offsets. The values in this study are based on the average of different sources examined.

7.2 Influence of changing LULUCF accounting rules

Land use, land use change and forestry (LULUCF) is not explicitly included in the Climate and Energy Package. However, rules on accounting for LULUCF could be included when moving to a 30% greenhouse gas reduction target.

LULUCF plays an important role in the international climate change architecture under the Kyoto Protocol. Different options for LULUCF accounting are discussed for the period

after 2012. These would affect the calculation of emissions in the base year and would allow alteration of the final emissions level for the 2020 reduction target.

In an ideal situation, LULUCF accounting systems would contribute to real emission reductions, with proven CO_2 removals from new or enhanced sinks, by further policy intervention. However, depending on the strictness of the rules, some CO_2 removals by sinks would be expected to occur anyway in the absence of additional policy. Such 'lenient LULUCF rules' would not contribute to real emission reductions as they would allow emissions in other sectors to increase (UNEP, 2010 p.37).

The accounting options assessed here are based on different proposals discussed in the international negotiations under the Kyoto Protocol. The European Commission discusses several of the options in their staff working paper (European Commission 2010a). These are:

- Option 0: no changes to Kyoto accounting rules after 2012. The large removals from forest management were capped at an individual level per country for the period 2008 to 2012. It is assumed to be set at the same level after 2012. Countries could choose to account for other subcategories and are assumed here to not change their current choice.
- Option 1: no changes to accounting rules except an evolution by 2020 towards mandatory accounting for all subcategories. For the forest management sector three discount rates are applied to all countries, rather than the country specific cap for 2008 to 2012.
- Option 2: option based on the current regime but accounting emissions/removals from forest management in the target year *and* in a base period. There would also be an evolution towards mandatory accounting for all subcategories by 2020.
- Option 3: option based on the current regime but the emission flux of the forest management sector would be compared to a forward looking baseline for forest management.
- Option 4: accounting of emissions and removals of all subcategories in the base year and in the target year.

Apart from the net/net accounting approach, considering reference emissions in a single year, the EU is also interested in reference levels with a band.[7]

The table below includes an assessment of the options 1, 2 and 4 (European Commission 2010a). The results show the impact, of the different options for accounting rules of LULUCF, on the amount of emissions or absorptions accounted for, compared to 1990 emissions (excluding LULUCF). For all options physically the same forest and therefore the same emissions / removals to the atmosphere are assumed. These can however, be accounted differently, towards meeting the national target.

[7] Instead of reference emission level from a base year an interval, also called band or bar, is added to the reference emission level. Only emission changes exceeding this interval are accounted for.

A negative value of -1.9 for the EU means that under these accounting rules, forests represent a carbon uptake and that approximately 2% of the required 30% reductions can be achieved through LULUCF accounting.

We also considered an independent assessment of the accounting rules for LULUCF (PIK as for www.climateactiontracker.org). These estimates are in the same order of magnitude as those shown in Table 4.

From all of the options, a reasonable average rate would be 2% of 1990 emissions. The extreme case of 8.7- 8.8% is highly unlikely to be the outcome of the international negotiations, because it would allow 100% accounting for the removals from forest management. This option is unacceptable to most countries. For our further suppositions we adopt a discount factor for forest management of 85%, which is analogous to the current rules under the Kyoto Protocol. However, changes in this discounting rate would lead to substantially different results.

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

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

Table 4 Impact of different LULUCF accounting options on developed countries' targets (Source: European Commission 2010a)

7.3 Remaining need for domestic action after application of LULUCF accounting rules and using offsets

To identify the remaining required domestic reduction effort, when moving from a 20% target to a 30% target, we have to consider both offsets and LULUCF accounting.

Reductions from the Climate and Energy Package with a 20% reduction target would require 16 to 18% domestic reductions will 2 to 4% achieved through offsets.

Under a potential 30% reduction target, the amount of offsets would be 7 to 9% and LULUCF accounting could add another 2% (0 to 9%). Therefore, the remaining domestic

emissions reduction effort would be approximately 20% below 1990 levels and 9% below 2020 BAU levels[8], when assuming a likely outcome of the negotiations on LULUCF accounting rules. However, other accounting rules have the potential to cover another 7%.

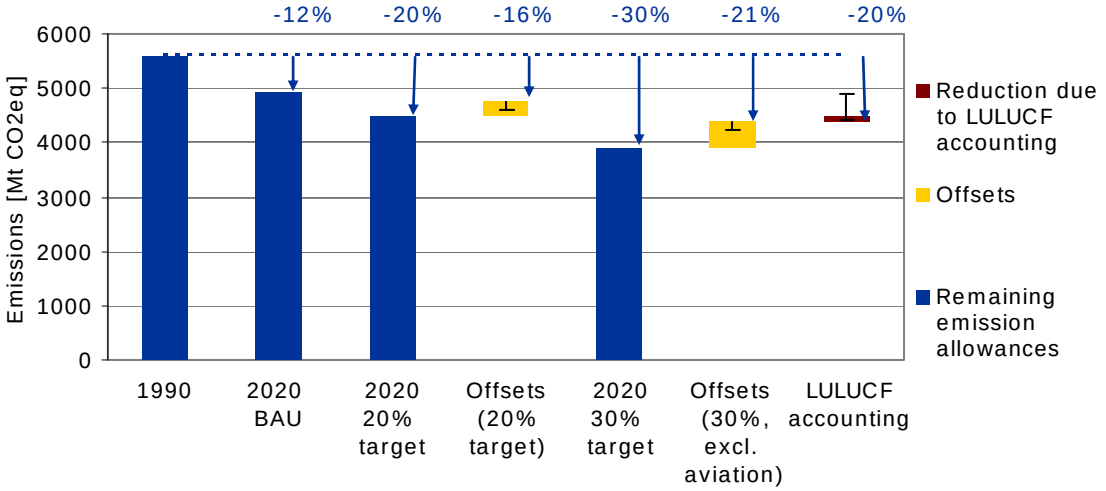

Figure 11 Effect of offsets and changes in LULUCF accounting rules on the 30% reduction target (excluding aviation)

[8] Individual percentages may not add up due to rounding.

8 Comparison

This chapter compares the results of the eight cases analysed in the previous chapters.

Figure 12 provides an overview of the permitted emissions per sector under the eight cases. Figure 13 provides an overview of the cap level of the EU ETS under the seven cases. The domestic emissions per sector (first bar) and the offsets and forestry that can be used (second bar), are shown in the figure below.

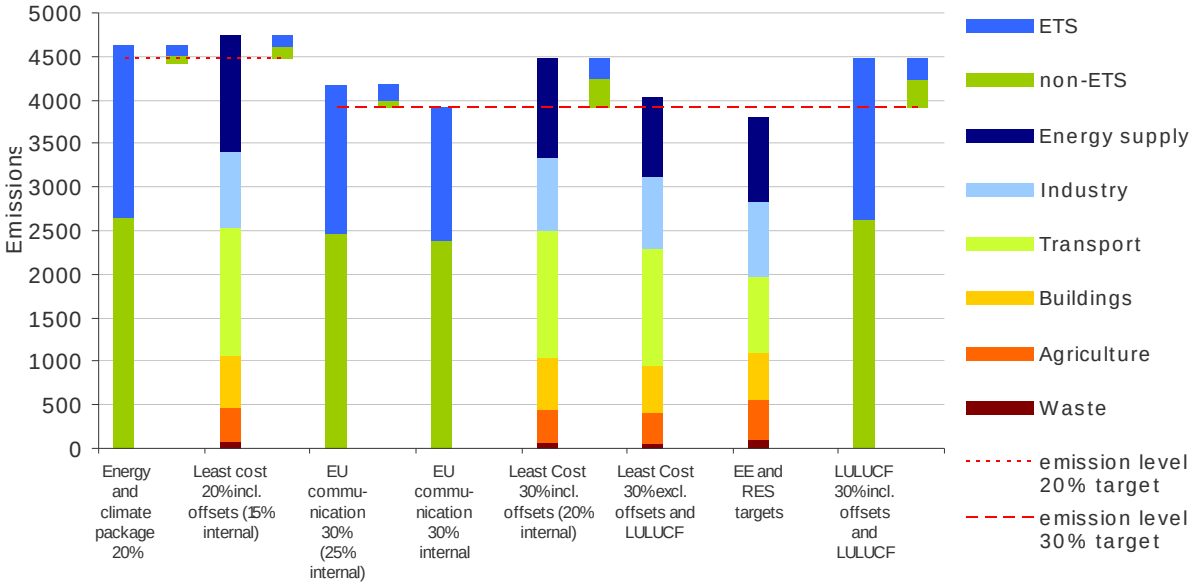

Figure 12 Resulting domestic emissions split per sector (first bars) and reductions through offsets and forestry (second bars)

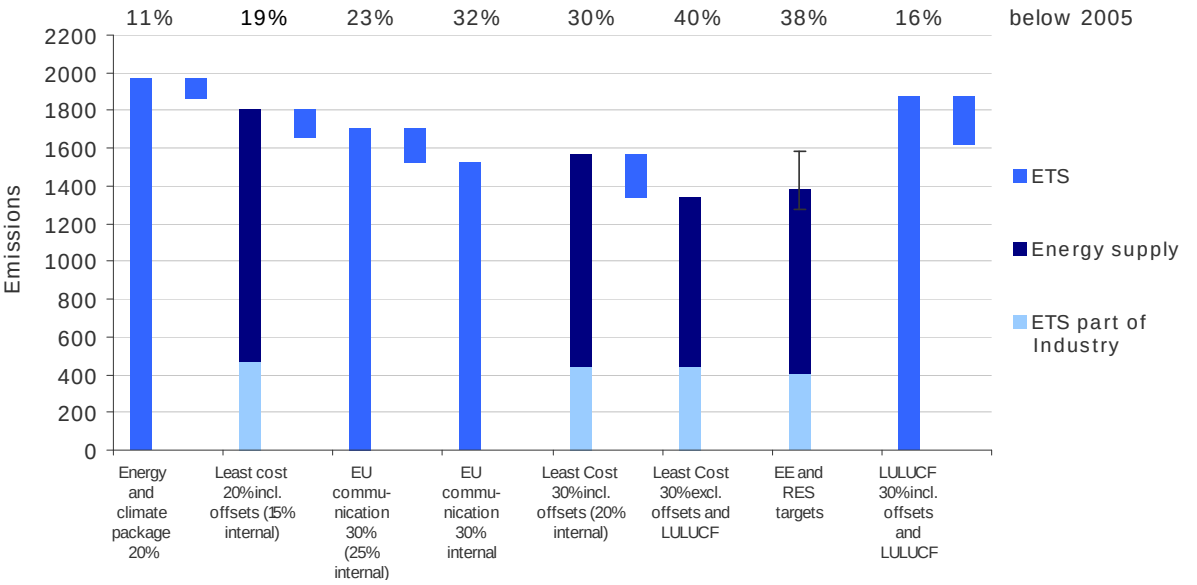

Figure 13 Resulting domestic emissions in the ETS sectors in 2020 (first bars) and reductions through offsets and forestry (second bars).

We make the following observations from the two figures:

- Climate and Energy Package 20%: In the current Climate and Energy Package, a nominal 20% target is reached. Domestic emissions can be higher, because offsets are permitted (equivalent to around 2 to 4% of 1990 emissions).
- Least-cost approach incl. offsets 20% (15% internal): After the recession, the reductions would be spread similarly to what has been agreed in the Climate and Energy Package. Our least-cost results indicate more reductions in the ETS sectors.
- EU commission proposal: the illustrative calculations by the Commission for a cost efficient spread of 25% and 30% domestic reductions are in accordance with our calculations.
- The LULUCF option permits the maximum amount of offsets.

8.1 Comparison to what would be required in the long term

The following figures compare resulting domestic emissions to two sets of long-term paths:

- an ideallised linear path, from the 2010 level to an 80- 95% reduction, by 2050
- sectoral long-term pathways to 2050, of CO_2 emissions from combustion as described in Guivarch and Rozenberg 2011.

Although the assumptions for the first, a straight line, might not be the optimal reduction path, it is still an indication of if the resulting emissions are in accordance with the long-term goals. If one sector reduces less than the ideal straight path (e.g. transport), then another sector may need to reduce further. The second path indicates sectoral emission reduction paths. For a detailed analysis of the long-term cost implications of short term actions see Guivarch and Rozenberg 2011.

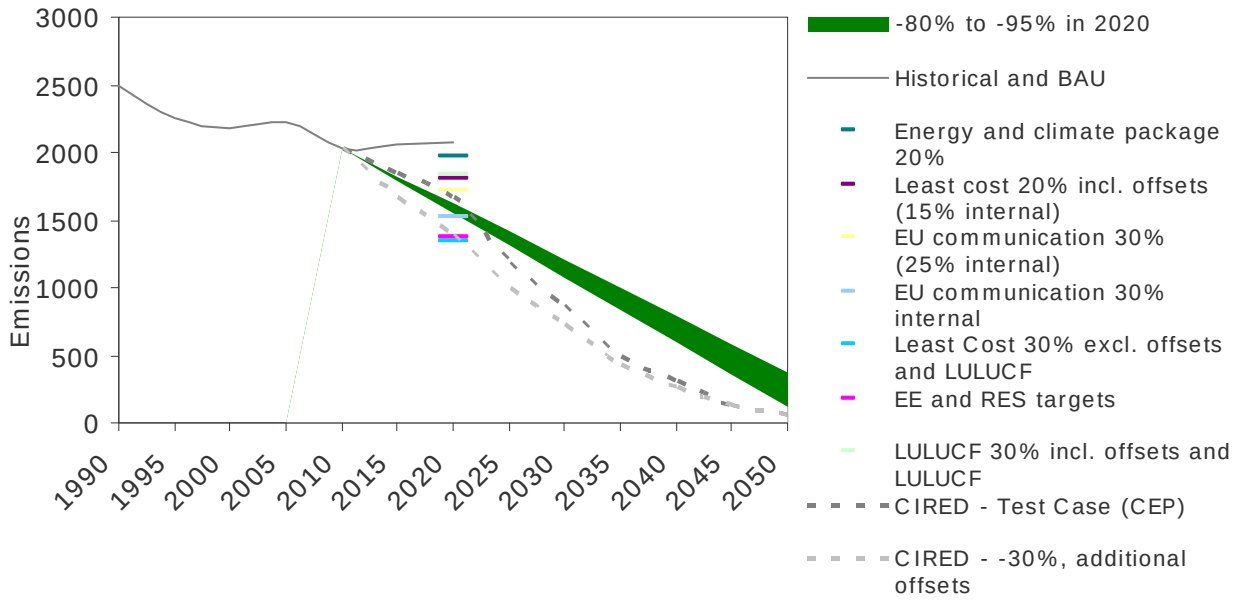

Figure 14 Long term comparison - emissions of the sectors covered under the ETS

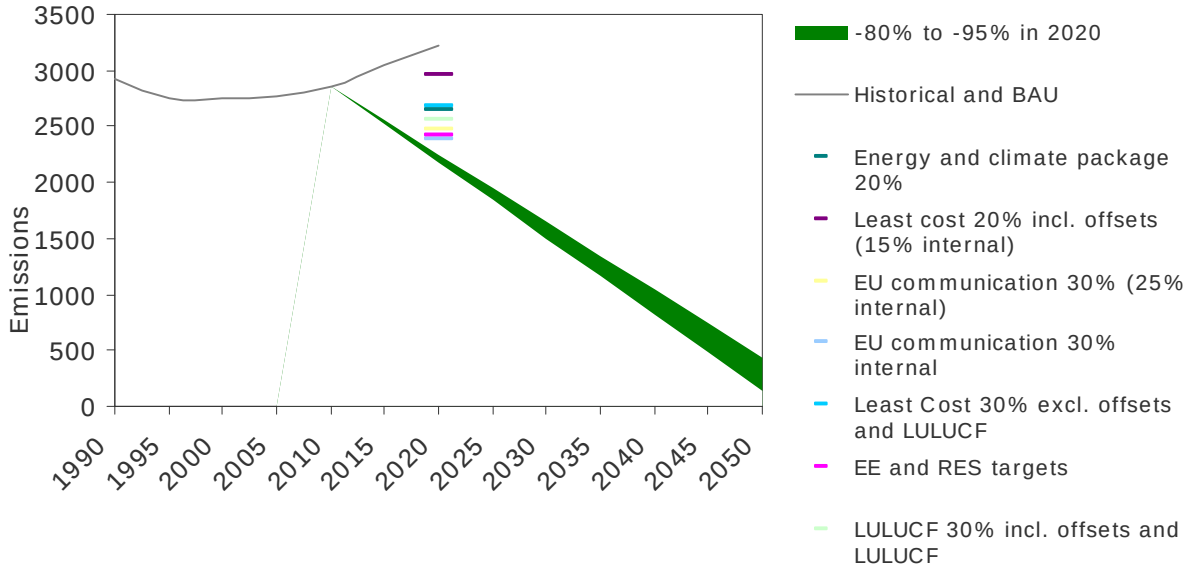

Figure 15 Long term comparison – emissions of the sectors not covered by the ETS

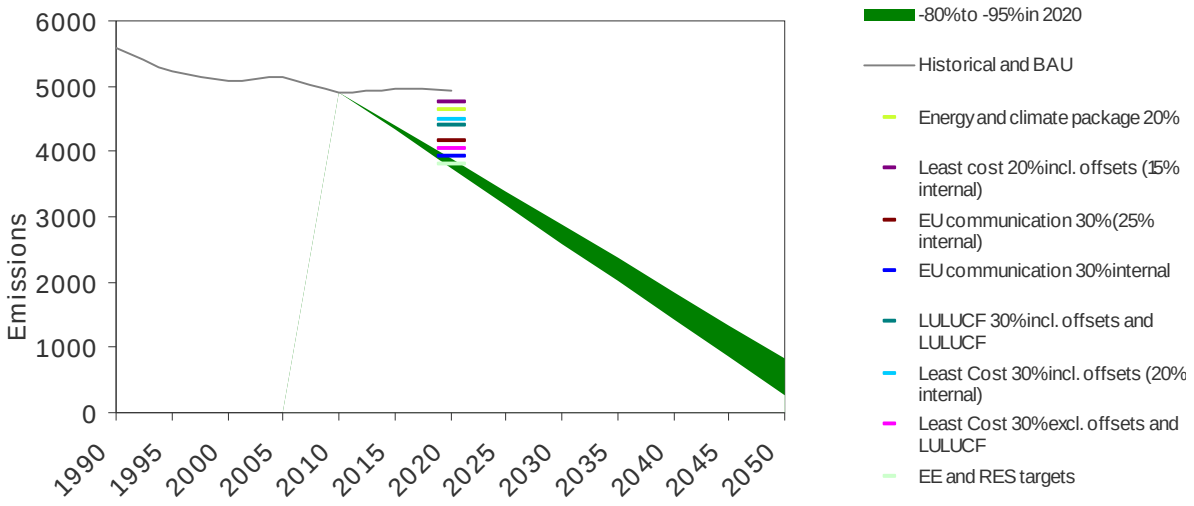

Figure 16 Long term comparison - total domestic emissions (excl. LULUCF)[9]

[9] For all scenarios except the least cost scenarios international transport is also excluded. Under the least cost scenario the PRIMES 2009 data used did not distinguish sufficiently between international aviation and national aviation. International shipping is excluded though.

9 Options to change policy instruments to move to a 30% target

The EU has several options for changing current policy instruments to progress towards the 30% target. Some of the options are discussed in the recent Commission Communication (COM(2010) 265 final).

The most obvious and cost-effective option is to spur energy efficiency measures. Wesselink et al. 2010 show that these can cover as much as half of the abatement effort required for deep greenhouse gas reductions, at the lowest cost. Several instruments can contribute to increased energy savings:

- Ambitious energy or CO_2 standards for appliances and cars
- Development of more ambitious and tailored national energy efficiency policies, based on binding national targets
- Creation of required energy efficiency investment funds, financed by both private and public money:
    - at a national level through recycled ETS-revenues
    - at the EU level by redirecting financing under the structural and cohesion funds

The policies for renewable energy could also be strengthened. Although the targets are ambitious and binding, further policies could be implemented to achieve these targets. Recent reports suggest, that the implementation of policy instruments, to reach the renewable targets, is quite advanced (Held et al. 2010).

The ETS is regarded as the primary tool to drive emission reductions. Its cap would need to be adjusted if changes occur in the policy instruments mentioned above. The cap could be adjusted or, a share of the allowances planned for auction could be set aside. It is likely that, although fewer allowances are auctioned, the revenues from auctioning will increase due to increasing prices.

The EU could also adjust the effort sharing decision for those sectors not covered under the EU ETS, however, this would require a detailed discussion on the emission levels of each Member State.

The Commission Communication also mentions a carbon tax without any further specification. A new instrument such as this, would have an impact that overlaps with all other policies.

The Commission Communication also suggests directing a greater volume of cohesion policy funding towards green investments.

Land use, land use change and forestry (LULUCF) activities were not included in the 2008 Climate and Energy Package and so, could potentially contribute to achieving an enhanced target. These, and offsets from emission reductions projects outside of the EU are discussed in chapter 5.

10 Conclusions

This work illustrates that there is a need to carefully reconsider the balance of the different 2020 targets and objectives. These changes are made necessary due to the recession and recent policy developments.

The full implementation of the energy efficiency and the renewables target would lead to an emission level in 2020, which is significantly lower than 20% below the 1990. Our results suggest a reduction of up to 30%. Assuming additional reductions in non-energy sectors, domestically, a reduction up to 32% is possible. Implemented policies are not yet sufficient to meet the energy efficiency target, despite the cost effective potential.

The cap of the Emissions Trading System will need to be adjusted if energy efficiency and renewables targets are to be met. Significantly fewer emissions would then occur in the sectors covered under the Emissions Trading System, than under the current cap. According to our calculations, a reduction of 29 to 43% below the 2005 level, in the emissions covered by the ETS, is the result of the energy efficiency and renewables target. This is compared to the current cap of 21% below the 2005 level.

The 30% GHG reduction target could also be met by increasing the permitted quota of offsets and allowances from land use, land-use change and forestry (LULUCF). Offsets can contribute up to 4% of 1990 emissions for the 20% target and up to 9% for the 30% target. Allowances from land use, land-use change and forestry could contribute around 2% of 1990 for reaching the 30% target. The value depends on the accounting rule chosen and ranges from 0 - 9%. Allowing the maximum of offsets and likely option for LULUCF, *domestic* emissions could be 20 - 22% below 1990 and still nominally meet the 30% target.

A 25 - 30% reduction of domestic emissions in the EU, in 2020 compared to 1990, would be conducive to the long-term goal of reducing emissions by 80 - 95%, by 2050. This can be achieved by enhancing energy efficiency measures and initialising the transformation process in those sectors not covered by the ETS.

For individual policy areas we draw the following conclusions:

- **Energy efficiency:** Current policy efforts on energy efficiency are not sufficient to meet the EU energy efficiency target. Efforts can be increased through existing directives (energy services, energy performance in buildings, eco design, road transport) or by implementing new energy efficiency targets. Significant cost effective mitigation potential does exist (Wesselink et al. 2010).
- **ETS:** The emissions originating from those sectors covered by the ETS are dependant on the policies intended to reduce electricity use. The EU ETS cap would need to be set at (percentage below 2005 in 2020):
    - 32 - 40% for a total domestic reduction of 30% to ensure a least cost approach across all sectors
    - 29 - 43% to be consistent with EE and RES targets, also leading to a total domestic reduction of 30%

- **Renewables:** The policies for renewable energy could also be strengthened. Although the targets are ambitious and binding, further policies could be implemented to achieve these targets. Policy instruments to reach the renewable targets are advanced but need strengthening.

Appendix I: SERPEC update

For this project we updated the SERPEC MACC curve. We briefly describe here how this was done.

Under the original SERPEC MACC the total emission reductions potential was sufficient to reach a 30% emission reduction in 2020 below 1990. Through this update the emission reduction potential was reduced to only -28% below 1990. This can be explained in the method used to adapt the MACC curve. There are three important implications this method has for the -30% target (below 1990)

- A decrease in the baseline leads to a decrease in absolute emissions
- A decrease in the baseline also leads to a decrease in the reduction potential
- Furthermore the delay of action and the passing of time lead to a decrease in the available reduction potential

While bullet point number 1 has a positive effect on reaching the reduction target, the other two others have a negative effect Within our analysis the overall effect is negative, as there is only enough reduction potential to reach a -28% emission below 1990. This can be reasoned by the way we implemented the factor 'passage of time' or new base year.

Correction FTRL for the recession (2005-2020)

A key-question in updating the baseline is, to what extent the change in emission is due to reduced (recession caused) activities or due to increased policies[10]. For each sector we analysed the available Primes data and estimated the share of each of the two. We then adjusted the downward scaling accordingly.

Correction for new base year (2010)

In SERPEC we assumed for all options maximum feasible annual implementation rates of new clean technologies and fuels. Between 2005 and 2020 the annual rates were constant. Obviously, the maximum possible implementation rates under SERPEC have not been achieved in the 2005-2010 period. We therefore now assume that these maximum feasible implementation rates start from 2010 on. Reductions start from the 2010 emissions provided by the PRIMES 2009 model. This means that for all options on the cost-curve a correction factor of 10/15 (0.66) is applied, to correct for a 10 year rather than 15 year implementation period.

[10] Emission reductions caused by policies are not include in the FTRL baseline

Appendix II: Additional figures for long term reduction path

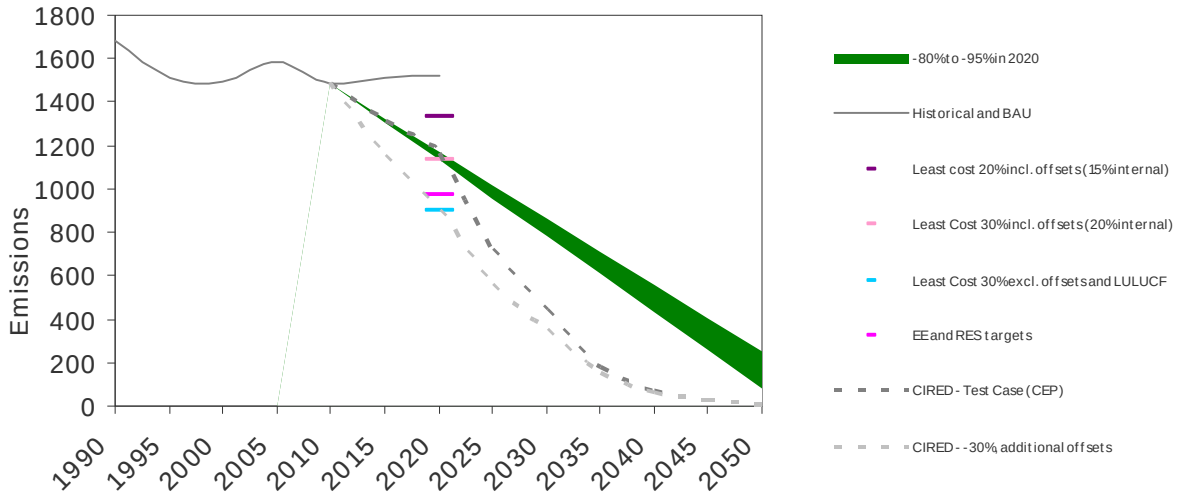

Figure 17 Long term comparison – emissions in the energy supply sectors

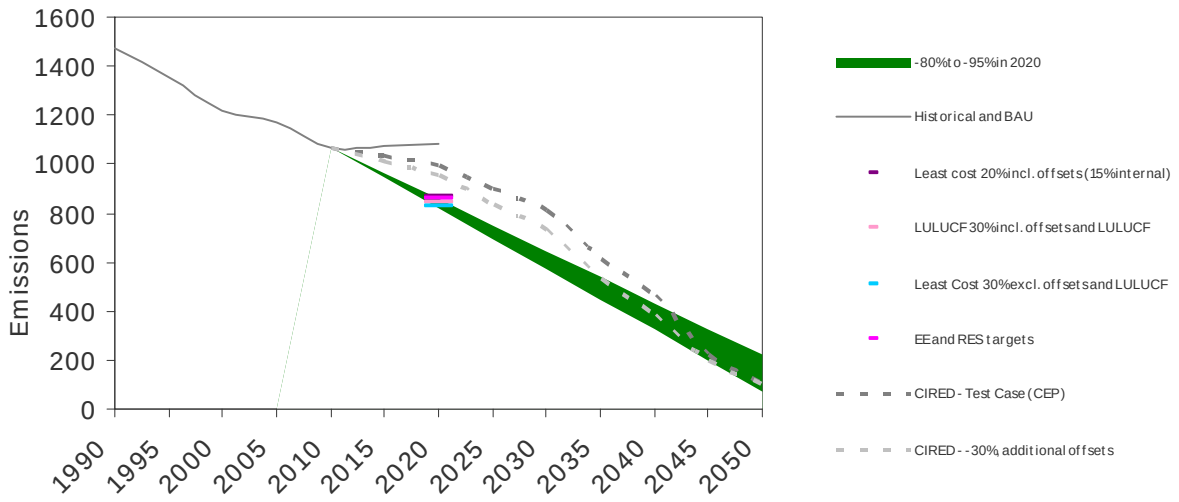

Figure 18 Long term comparison - results for industry

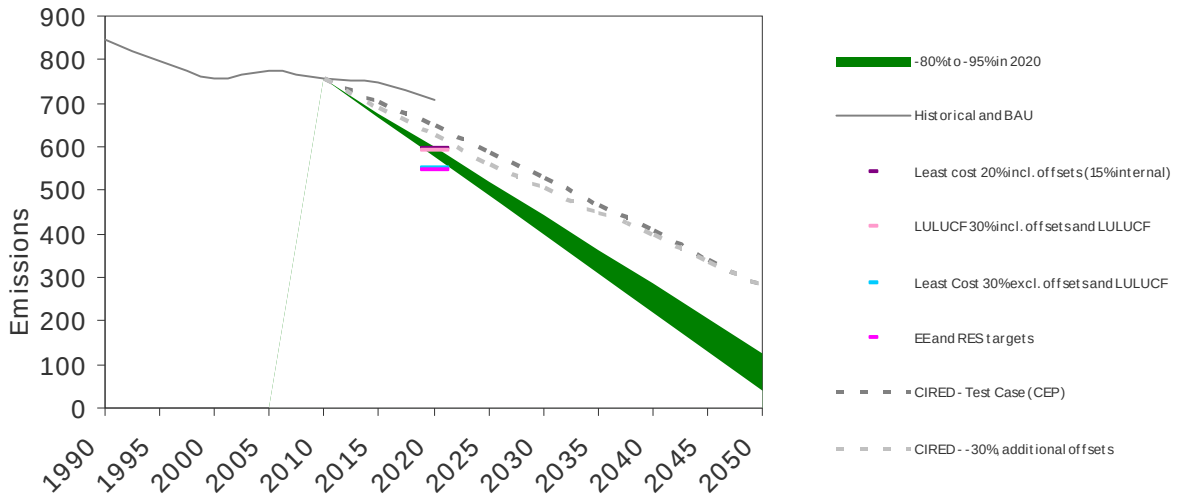

Figure 19 Long term comparison - results for buildings

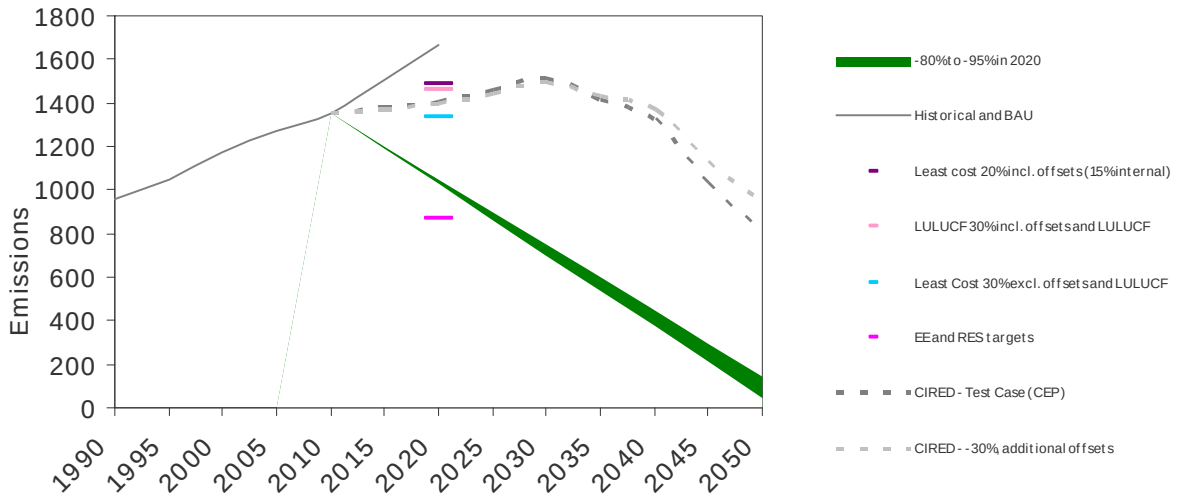

Figure 20 Long term comparison - emissions in the transport sector

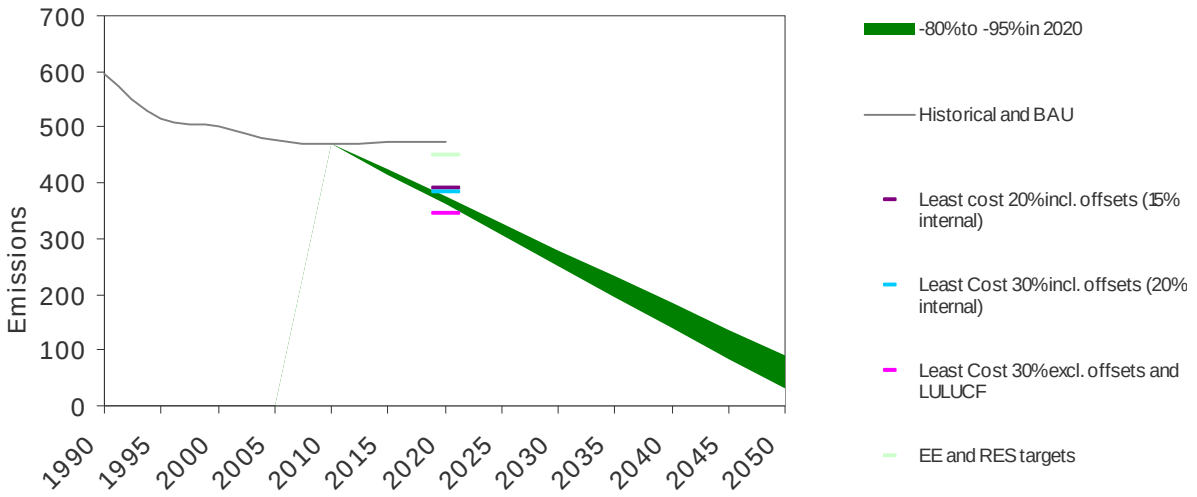

Figure 21 Long term comparison - results for agriculture

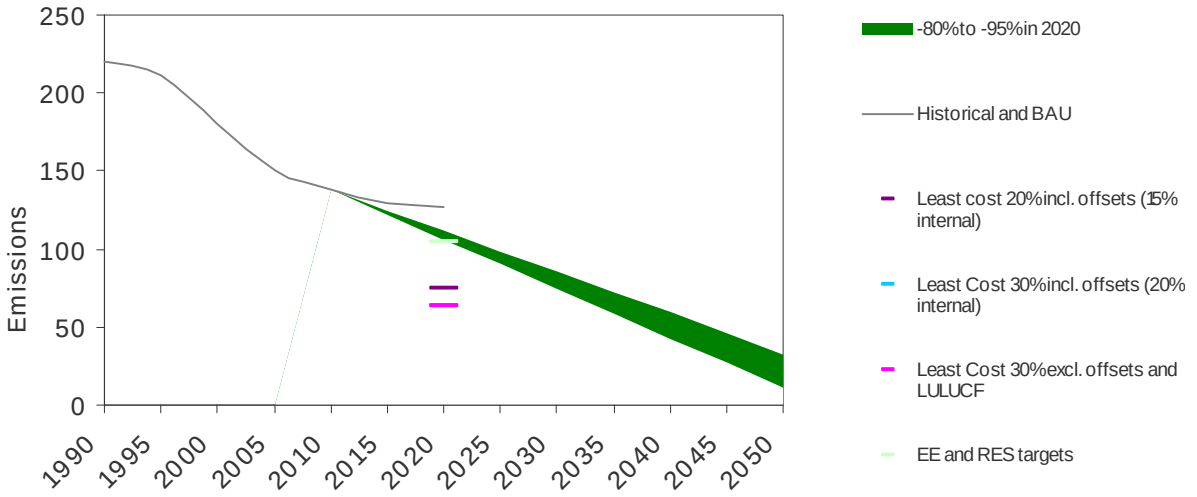

Figure 22 Long term comparison - results for waste

Appendix III: Use of offsets

Detailed description of the impact of the recession on the availability offsets in the EU

The emission cap is set for the second period (green line). It is allowed to achieve some of the reductions via offsets with CDM or JI credits (yellow). In addition, unused allowances from the second trading period can be banked and used in the third period. Because the recession led to unexpected emission reductions most of the allowed credits (yellow) in the second period will not be used. It is likely that the cap in the second period can be achieved without additional reduction effort. For the third period an amount of the reduction effort is allowed to be covered by offsets (yellow). In addition banked credits from the second period can be used (brown). The remaining domestic reduction effort is thus much smaller than it would have been without the recession.

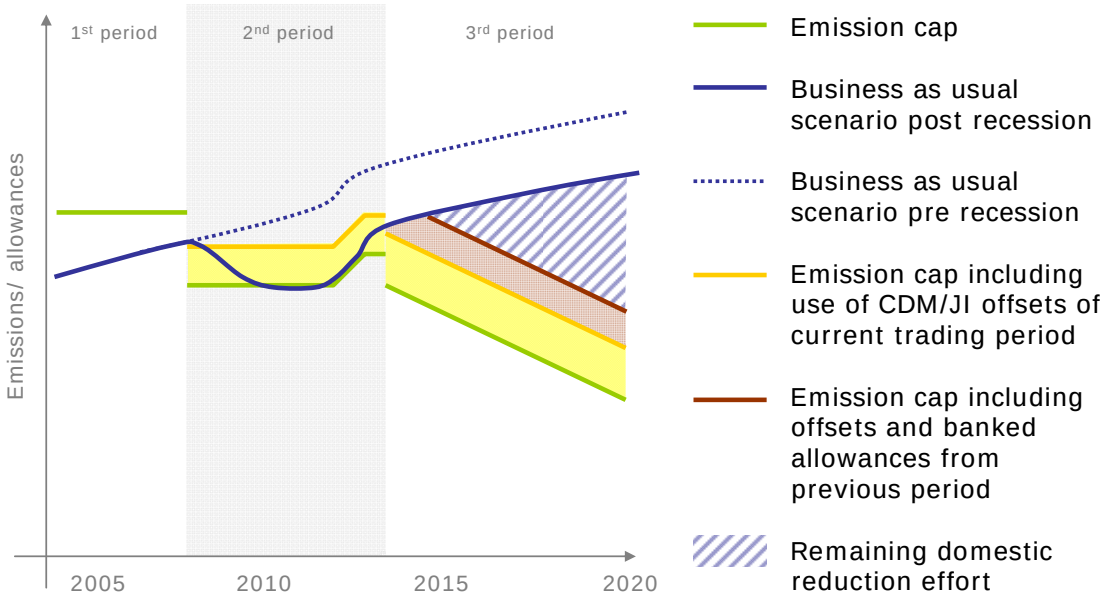

Figure 23 Emission caps and offsets in the EU ETS

Estimating the resulting use of offset credits - Overview of studies

The rules on how much credits can be used can be interpreted in different ways. The table below includes results of different studies on emissions, the amount of usable offsets and remaining emissions in 2020 for a 20% and a 30% emission reduction target of the EU.

Galharret 2010 assumes an even distribution of the additional 10% among ETS and non-ETS. Phylipsen and Wesselink 2010 split the additional effort among ETS and non-ETS sectors according to their share in 2005 emissions, which would be a bit more than 50% for non-ETS. This split has a considerable influence on the overall amount of offsets and could be discussed further. Other options, such as least cost distribution, would be possible.

		Galharret 2010	Graus 2008	Phylipsen and Wesselink 2010	{Höhne, 2008 4211 /id}	Assumptions in this study
	1990		5572		5590	5591
	ETS				*2432*	*2495*
	non-ETS				*3158*	*3097*
	2005	5211	5211		5141	5144
	ETS		*2340*	*2122*	*2177*	*2310*
	non-ETS		*2871*		*2964*	*2834*
	2020 BAU	5496	5496		5500	4938
	ETS		*2557*	*2622*	*2316*	*2297*
	non-ETS		*2940*		*3185*	*2642*
20% target	2020 20% target total emissions	4462	4458		4388	4473
	ETS		*1872*	*n.a. - 2102*	*1720*	
	Aviation			*n.a. - 232*		
	non-ETS		*2584*		*2668*	
	2008-2020 cumulative offsets	2688	1611			
	ETS	*2488*		*1636 - 1849*		
	non-ETS	*200*				
	2013-2020 offsets per year	230	100		189	209
	ETS excl. aviation			*n.a. - 192*	*100*	*105*
	Aviation			*n.a. - 6*		*n.a. - 6*
	non-ETS	*98*			*89*	*99*
	2020 total emissions after offsetting	4691	4679			
	ETS					
	non-ETS					
30% target	2020 30% target total emissions	3905				3914
	ETS			*1822.7*		
	non-ETS					
	2008-2020 cumulative offsets	3657				
	ETS			*2720*		
	non-ETS					
	2013-2020 offsets per year	350			468	409-489
	ETS excl. aviation				*207*	*172-208*
	Aviation			*15*	*15*	*n.a.-15*
	non-ETS				*247*	*223-266*
	2020 total emissions after offsetting	4255				4464-4544
	ETS					
	non-ETS					

Table 5 Reference emissions and offsets under a 20% and 30% target by 2020 in the EU[11] in $MtCO_2e$

[11] (Graus 2008) and (Galharret 2010) partly consider the possibility of banking EU Allowances (EUAs) under the Emission Trading Scheme. (Höhne 2008) do not consider banking of EUAs. (Phylipsen and Wesselink 2010) indirectly consider the

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