Choosing Efficient Combinations of Policy Instruments for Low-carbon development and Innovation to Achieve Europe's 2050 climate targets

Country report: The European Union

WP 1 – Taking stock of the current instrument mix

Contribution to Deliverable 1.2: Review of the existing instrument mix at EU level and in selected Member States

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List of Key Abbreviations

CCS	Carbon Capture and Storage
DEC	Display Energy Certificate
EE&EC	Energy Efficiency & Energy Consumption
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESD	Effort Sharing Decision
ETD	Energy Taxation Directive
EUA	EU (emission) Allowance
EU-ETS	European Union – Emissions Trading System
GOO	Guarantee of Origin
GWP	Global Warming Potential
LULUCF	Land Use, Land Use Change and Forestry
NVZ	Nitrate-Vulnerable Zone
NZEB	Near-Zero Emission Buildings
RED	Renewable Energy Directive

0 Executive summary

The EU has a range of climate policy instruments with varied objectives, targets groups and approaches to encourage the abatement of GHG emissions. Many have been in place for over twenty years and are designed to tackle wider environmental or other issues, whilst some are newly introduced with the explicit objective of meeting the targets of the '20-20-20' targets, and beyond.

This report groups these policies into four main categories, or policy landscapes: carbon pricing, energy efficiency, renewable energy and non-CO_2 gases. Each landscape is populated with a different set of instruments.

- **Carbon Pricing** – The EU-ETS and the Energy Taxation Directive (ETD) experience little direct interaction (although there is some indirect overlap, on the production and consumption of electricity, for example). Their relationship is conflicting, as the design of the ETD produces incentive to consume carbon-intensive fuel (e.g. coal), over less carbon-intensive fuel (e.g. gas), for heating.

- **Energy Efficiency and Energy Consumption** – Along with the EU-ETS, the Effort Sharing Decision (ESD) and Energy Efficiency Directive (EED) and are the key instruments in this landscape. The EU-ETS and ESD provide complimentary sectoral coverage, but unequal abatement incentives. The ESD is a 'framework' instrument reliant on other instruments to fulfil its objectives. This includes the EED, which places energy-saving obligations on energy generators, suppliers and end-users. The remaining instruments are more sector-specific and target buildings, energy-related products and transport. The latter two sectors are subject to two complimentary instruments each – the Ecodesign and Energy Labelling Directives for the former, and CO_2 emission standards and labelling requirements for the latter. For both sectors, one instrument 'pushes' the market to efficiency using minimum standards; the other 'pulls' it towards higher efficiency using labelling and information provision. The Energy Performance of Buildings Directive (EPBD) performs both roles for buildings, through different provisions.

- **Promotion of Renewable Sources of Energy** – The Renewable Energy Directive (RED) and EU-ETS are the key instruments in this landscape. Whilst they are generally mutually supportive in achieving the deployment of renewables, their interaction is cost-inefficient regarding centralised electricity production in particular. The interaction does not necessarily induce emission mitigation in the EU-ETS sector, as allowances are able to shift to other Member States and non-electricity production sectors. The RED also encourages distributed energy generation, supported by the EPBD, and renewable transport, supported effectively by CO_2 emission standards and labelling for passenger cars.

- **Non-CO_2 GHG Emissions** – The ESD is the key instrument in this landscape, supported and implemented by F-Gas Regulations, Landfill Directive, Nitrates Directive, Land Use, Land Use Change and Forestry (LULUCF) Accounting Rules and the EU-ETS for specific GHGs and industrial processes. These instruments are largely neutral in their relationship,

as they target specific products, sectors and GHGs with little overlap – with a minor exception of the Nitrates Directive and LULUCF Accounting Rules, concerning N_2O emissions.

Each of the four policy landscapes are relatively well populated. Some contain few but comprehensive pieces of legislation (Carbon Pricing), others contain more targeted, technical instruments (Non-CO_2 GHGs), whilst some contain a mixture (EE&EC and Promotion of Renewables). The instruments discussed are highly varied in their design, approach and target group, and are borne out of a variety of and trade-offs between political, legal and administrative factors.

Such trade-offs have led to some overlap in regulation and incentives, some of which work in mutual support, and others that work against each other. This produces some static and dynamic inefficiency, often due to the multitude of specific objectives (not always emission mitigation or even environmental objectives), and the pursuit of political acceptance and administrative and legal feasibility (e.g. differentiated national targets and obligations). Despite this, the evidence suggests that innovation and emission reductions have occurred as a result of individual instruments (such as the Ecodesign Directive), although attributing the contribution of individual instruments is a difficult task, and other factors undoubtedly have a significant impact on emission trends. A number of instruments (including such recasts), are very recent, and have yet to exercise their influence (e.g. EED), whilst others have produced clearly positive results (e.g. Ecodesign Directive), and yet others appear to have had a negligible effect (e.g. CO_2 labeling for passenger cars). The overall instrument mix is relatively flexible (although this varies significantly between instruments), with policy learning in evidence through Directive recasts and other instrument adjustments over time.

In summary, whilst the current instrument mix is not ‘optimal’ and has significant room for improvement in its design, it has been relatively successful in pursuing the overarching objective of GHG emission reduction over time. It is likely that the target of a 20% reduction in emissions from 1990 levels will be achieved, however it is agreed that many changes and additions to the current instrument mix design and ambition will be required to meet an ambitious 2050 target of an 80% reduction below 1990 levels (European Environment Agency, 2012), especially in an ‘optimal’ manner.

1 Description of policy landscapes

1.1 Classification of the instruments previously selected into policy landscapes

The objective of this report (and report series) is to perform an initial 'stock-take' of the climate policy instrument mix at the EU-Level and a representative group of Member States – the United Kingdom, Germany, France, Spain, Italy, the Netherlands, Poland and the Czech Republic. An initial list of up to 50 instruments from each country and EU-level was created, from which up to 15 key instruments for each state covering a broad selection of the economy, instrument type and objectives were selected for further analysis. Please refer to the Taxonomy of Instruments, developed under Task 1.1 of CECILIA2050, for a full description of instrument classification. For each report, the selected instruments were categorised into policy 'landscapes', described below.

(1) **Carbon Pricing:** this includes policies that price CO_2 emissions or otherwise change the relative prices of fuel use, depending on the carbon intensities of fuels. Apart from the obvious candidates (carbon taxes and emissions trading) this would also include the reform or removal of fossil fuel subsidies;

(2) **Energy Efficiency and Energy Consumption:** this includes measures targeted at either increasing the efficiency of the energy sector, including power generation / combustion processes, transmission of energy (heat, electricity) and end-use efficiency, or at reducing overall energy consumption (demand-side management, energy saving, sufficiency);

(3) **Promotion of Renewable Sources of Energy:** this includes policies aimed at increasing the share of energy from renewable sources (solar, wind, hydro, biomass, geothermal);

(4) **Non-Carbon Dioxide Greenhouse Gases:** this covers policies geared at reducing non-CO_2 greenhouse gas emissions, typically from sectors other than the energy sector. It may include emissions like methane emissions from landfills or animal husbandry, N_2O emissions from agriculture, or greenhouse gas emissions from chemical industries (SF6, NF3, HFC etc.)

The list of instruments for the EU, along with their landscape classifications may be seen in Table 1, below. This report describes each instrument based on a set of tabulated information found in Annex 1, and an attempt at assessing their individual 'optimality', based on the concept developed for use in the CECILIA 2050 project also developed in Task 1.1, is provided. Descriptions of interactions between instruments within each landscape are also provided, based on tables found in Annex 2. The categories and methods of interaction are based on best practice in instrument interaction assessment, and are completed in pairs against a single key instrument, or when important interactions between non-key instruments are present.

The resulting optimality of each landscape based on instruments and their interactions are then assessed, followed by interactions between each landscape and, finally, an analysis of the optimality of the climate policy mix as a whole at the EU-level is provided.

Table 1 - Policy instruments and policy landscapes

	Policy Landscapes			
Policy Instrument	**Carbon Pricing**	**Energy Efficiency and Energy Consumption**	**Promotion of Renewable Sources of Energy**	**Non-Carbon Dioxide GHGs**
EU ETS	✓	✓	✓	✓
Energy taxation Directive	✓	✓		
Effort Sharing Decision		✓	✓	✓
Energy Efficiency Directive		✓		
Energy Performance of Buildings Directive		✓	✓	
Ecodesign Directive		✓		
Energy Labelling Directive		✓		
Emission Standards for Passenger Cards		✓	✓	
CO_2 Labelling for Passenger Cars		✓	✓	
Renewable Energy Directive			✓	
CCS Directive			✓	
F-Gas Regulations				✓
Landfill Directive				✓
Nitrates Directive				✓
LULUCF Accounting Rules				✓

1.2 Detailed description of instruments within each policy landscape

This section describes elements of each policy instrument presented in Table 1. The purpose of the description is twofold: to provide input to the analysis of policy interactions in Section 2 of this report, and to evaluate each selected instrument in the light of the definition of the concept of optimality provided in Task 1.1 of CECILIA2050. The policy instruments are grouped together in policy landscapes (following the classification in Table 1), and described in the above section.

1.2.1 Carbon Pricing

EU Emissions Trading System (EU-ETS)

The EU-ETS began operation in 2005, and is the world's first and largest multi-country, multi-sector CO_2 emissions cap-and-trade scheme, with the objective of reducing GHG (primarily CO_2) emissions within the EU. Its introduction was largely in response to the obligations that the EU and its Member States had agreed upon in the Kyoto Protocol (GHG emissions to reach 8% below 1990 levels per annum between 2008 and 2012, on average). As it regulates a significant share of the overall emissions and addresses sectors that are key to the long-term transformation towards a low carbon economy, it is considered as the cornerstone of EU climate change mitigation policy.

It was the belief of the European Commission that a cap-and-trade system, which uses tradable emissions permits of decreasing volumes to allow abatement where cheapest, would be the most cost-effective manner to meet these commitments (following failed attempts to introduce an EU-wide carbon tax). Directive 2003/87/EC (Emission Trading Directive) established the EU-ETS as EU law. When the EU-ETS came into effect on 1st January 2005, it covered around 11,500 power and heat generation and industrial installations across the then EU-25, responsible for around 40% of the EU's CO_2 emissions. Bulgaria, Romania and Croatia joined the EU ETS upon their accession to the EU in 2007 and 2013, respectively. Iceland, Norway and Lichtenstein (non-EU Member States) joined the scheme at the beginning of Phase 2 (2008). At present, the EU-ETS covers around 50% of the EU's CO_2 emissions (40% total GHGs). At launch, the EU-ETS covered CO_2 emissions from power and heat generation and energy-intensive industry sectors (including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals). Participation in the EU ETS is mandatory for installations within these sectors, but in some sectors only plants above a certain size are included (e.g. installations with combustion of fuels with a total rated thermal input exceeding 20MW).

The EU-ETS was designed with an initial three Phases. Phase 1 (2005-2007) was conceived as a 'learning' phase. Article 9 of the ETS Directive specified that for Phases 1 & 2, 'National Allocation Plans' (NAPs) should be developed by each Member State, stating how EUAs (European Union Allowances) will be allocated amongst their installations, following a set of criteria stated in Annex III of the Directive. A key criteria is that the sum of proposed allocations should not jeopardise achievement of the agreed national emissions caps under Kyoto or the EU's Burden Sharing Agreement (BSA) for the Union-wide target, by 2012 (end of Phase 2). As such, each initial national allocation was set as the lesser of 'Business as Usual' (BAU) projections, or the 2005 value on a linear trajectory between 1990 emissions and the 2012 Kyoto/BSA target (Ellerman, Convery & De Perthuis, 2010). This meant that whilst many states proposed EUAs allocations at a decreasing volume over time, many states (especially the those which achieved accession in 2004 or later), which had Kyoto/BSA targets allowing growth in emissions, allocated increasing volumes of EUAs. In Phase 1, a minimum of 95% of all EUAs were required to be 'grandfathered' (allocated for free). Only four Member States chose to auction any allowances (Denmark, Hungary, Lithuania and Ireland), amounting to around 0.13% of total EUAs (Ellerman, Convery & De Perthuis, 2010).

In Phase 2 (2008 – 2012), the cap was around 6.5% lower than that of Phase 1. Member States were permitted to auction up to 10% of their EUA allocation. However, only eight did so (the initial four, plus Germany, the Netherlands, Austria and the UK), and not all to the permitted level, although the total volume increased to just fewer than 3% (Ellerman, Convery & De Perthuis, 2010). From 2012, commercial aviation with flights to and from any EU-ETS country airport (including to and from any other domestic, intra-EU or international airport), are covered in principle. However, in November of 2012, the European Commission announced a moratorium on following through with the inclusion of aviation, pending progress in the international negotiations under ICAO (the International Civil Aviation Organisation), following massive opposition from international actors. The full inclusion of aviation in the EU-ETS is therefore uncertain.

The 2004 'Linking Directive' (2004/101/EC), passed as an amendment to the original EU-ETS Directive, allows installations to purchase emission reduction credits generated by the Kyoto mechanisms - the Clean Development Mechanism (CDM) and Joint Implementation (JI). The objective of this amendment is to reduce the cost of EU-ETS compliance through carrying out cheaper abatement measures than might otherwise be possible. CDM projects are undertaken in non-Annex I nations (as listed in the Kyoto Protocol), whilst JI projects are undertaken within Annex I states. A CER (Certified Emission Reduction) and ERU (Emission Reduction Unit) are issued for each tonne of CO_2 (tCO_2) avoided, for CDM and JI projects respectively. Credits are currently accepted from most projects, excluding nuclear energy, afforestation, reforestation, and (from the beginning of Phase 3), projects involving the destruction of industrial gasses. Different rules have applied for the use of CERs and ERUs in the different phases. In Phase 1, there was no limit on the level of such credits that may be used to meet obligations. Across Phase 2 and 3, a cap of 1.7 billion tCO_2e of credits is in place (approximately half of the projected emissions reductions required across this period). Unused credits from Phase 2 were open for transfer ('banking') to Phase 3, subject to Member State imposed limits and controls.

Installations are able to 'bank' EUAs they hold for surrender in any future year within the Phase for which they were issued. EUAs were also bankable from Phase 2 for use in Phase 3 (although any banked permits were replaced with an equivalent Phase 3 vintage permit), but this was not possible between Phases 1 and 2. Banking is currently permitted between Phase 3 and any subsequent Phases. 'Borrowing', the surrender of credits in one year with a vintage for the year immediately following, it also possible within Phases. This is not possible, however, between Phases (without incurring penalties, discussed below).

A further legislative adjustment, imposed by amending Directive 2009/29/EC, contains far-reaching adjustments to the EU-ETS for Phase 3 (2013-2020). Additional sectors and GHGs (N_2O from nitric, adipic and glyoxalic acid production, and perfluorocarbons from aluminium production) also now fall under the remit of the EU-ETS. In Phase 3, NAPs are replaced by centralised allocation at the EU level. An EU-wide cap of 2.04 billion permits has been set for 2013, with subsequent annual caps reducing by a volume equal to 1.74% of the average volume of allowances issued annually in Phase 2 (equal to 34,000 EUAs). This cap is set based on a linear reduction from 2010 allocations to the 2020 EU GHG emissions target (20% below 1990 levels), and the contribution required from EU-ETS sectors. The 2020 cap will then be 21% lower than the cap imposed at the beginning of Phase 1, in 2005. This annually

reducing cap is set to continue beyond 2020 and the end of Phase 3, pending revision of the system no later than 2025.

In contrast to Phases 1 & 2, no EUAs may be grandfathered to the power sector in Phase 3. However, a derogation under Article 10c of the revised Directive allows eight of the more recent Member States (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania), to gradually reduce free allocation to this sector on an annual basis to zero by 2019. Latvia and Malta were also eligible for this derogation, but chose not to make use of it. A shift to auctioning as the preferred method of allocation is taking place progressively in the remaining sectors, with the manufacturing industry receiving 80% EUAs for free, reducing in a linear fashion to 30% in 2020. Aviation allowances will be 85% grandfathered across the whole Phase. Due to the prevalence of the power sector at least 40% of total EUAs will be auctioned in 2013, and increasing to 2020 (with an average of between 50% and 60% across the whole Phase) (European Commission, 2013c). A common, centrally operated auction platform will be the primary mechanism by which installations may purchase non-grandfathered EUAs. The Commission expects this approach, rather than national level platforms, will provide the most cost effective approach to EUA distribution. However, Member States are able to opt-out of the common platform and operate their own auctioning mechanism. Germany, Poland and the UK have thus far chosen to operate their own system.

For the sectors still able to receive grandfathered allowances, installations will receive varied volumes of allowances based on benchmarks, calculated for each product, as determined by the Commissions 2011 'Benchmarking Decision'. A 'benchmark' value is calculated as the average GHG performance of the top 10% performing installations in the EU producing a given product (e.g. pulp and paper, nitric acid, etc.). In general, installations that meet these benchmarks (i.e. roughly the top 5%) will receive free allocation for all their emissions, whilst those that do not meet these benchmarks (the remaining 95%, roughly), will receive proportionally less. Those industries with particular sensitivity to international competition and a higher risk of 'carbon leakage', will generally receive a higher share of allowances that those that are not. The Benchmarking Decision lays down harmonised EU-wide rules for the calculation of free allocation to installations across all relevant sectors. All states must produce 'National Implementation Measures' (NIMs), following this prescribed methodology, for all relevant installations within their territory.

Article 27 of the Directive also states that 'small emitters' (under 25,000tCO_2/year, with a rated thermal input below 35MW – stationary installations only, which excludes aviation), and hospitals are able to opt-out of the EU-ETS in Phase 3, on the condition that such installations participate in emissions reductions efforts commensurate to the reductions that might be expected by their continued participation. The objective of this opt-out is to reduce the administrative burden on these relatively insignificant emission sources.

Monitoring, reporting and verification (MRV) of EU-ETS emissions is a key element in successful and effective operation of this instrument. All installations (including aircraft operators) must follow the annual 'compliance cycle'. All participants must have an approved monitoring plan. An annual emissions report must be produced and verified by an accredited body before 31st March each year. Member States are responsible for approving monitoring

plans and ensuring accuracy of reporting (through spot-checks, for example), and general compliance with the provisions of the EU-ETS. Member States have general freedom to set nationally appropriate, effective, proportionate and dissuasive penalties for breaching the provisions of the Directive, however a set fine of €100 per tCO_2 in excess of the volume of allowances surrendered exists across all States (€40 in Phase 1). From the 1st January 2013, this value increases in line with the European index of consumer prices. The installation must also surrender additional allowances in the following calendar year equal to the volume in deficit. A list of installations in violation of these provisions should also be published.

As stated, Phase 3 has seen the operation of the EU-ETS become more centralised at the EU level. The Directorate-General for Climate Action - DG CLIMA – is responsible for the EU-level implementation of the EU-ETS. In Phases 1 and 2, NAPs were developed by each Member State, and subsequently NIMs for Phase 3. NIMs are drawn up following a strict methodology, compared to the relatively flexible approach afforded to Member States in compiling NAPs in the previous two Phases. Although Member States remain responsible for ensuring compliance and enforcement of the Directive's provisions, the framework within which they execute this duty is becoming increasingly standardised. Along with standardised reporting templates, all MRV activities in Phase 3 must now comply with two additional Commission Regulations aimed at increasing harmonisation – one specific to monitoring and reporting, the other to verification and accreditation (e.g. mutual recognition of accredited bodies). In addition, in 2011 the Commission proposed including EUAs within the scope of the revised rules for governing financial markets. This would mean prevention of market manipulation through practices such as the spreading of false information or rumours, the prevention of insider trading, improved transparency and anti-money laundering safeguards. At the Member State Level, departments and ministries responsible for the environment are the most prominent competent authorities responsible for the EU-ETS, with some States (e.g. Germany and the Netherlands), holding authorities dedicated to the EU-ETS alone.

Since its introduction, several adjustments have been made to the EU-ETS – and this is likely to continue. It was announced in August 2012 that a full two-way link with the Australian Emissions Trading Scheme would start no later than 1st July 2018, with an interim link beginning from 1st July 2015. Allowances from either system will be fully interchangeable. Negotiations are also underway with Switzerland, with the objective of linking the EU-ETS to the Swiss system. Several options for core structural reform, in response to perceived issues with the current structure, have also been proposed. These issues and the reform proposals are discussed below through the lens of 'optimality'.

The optimality of the EU-ETS has been the subject of debate since its introduction. As a cap-and-trade instrument it provides an emissions ceiling to the installations covered, and allows abatement to occur where cost is lowest (both spatially and sectorally). However, the official 'cap' is extended through the ability to use international credits. Due to this broad scope, there is relatively high static efficiency. However, not all CO_2 or wider GHG emission sources are covered, and thus an equalised marginal abatement cost is not established (although general cost-effectiveness is likely to improve to some extent through the link to the Australian scheme). The issue of EUA oversupply has plagued all Phases. In Phase 1, final verified emissions were over 4% lower than EUA availability. This was due to a combination of several factors, including poor data quality used to set the cap (few countries had an accurate idea of

emissions from the EU-ETS sectors alone, for example), and an underestimation of the rate of continued improvement in energy (and carbon) efficiency in Eastern Europe. Whilst the issue of poor data was solved for the Phase 2 allocations (as verified emissions data for 2005 were then available), a surplus of around 2 billion allowances remained by the end of Phase 2, with supply outpacing demand by around 20% (despite the Phase 2 cap being considered initially ambitious). This was likely due to the global financial crisis heavily reducing demand for EU-ETS sector output (electricity, industrial products, etc.), but also the record use of international credits and the early sale of Phase 3 allowances to fund the NER300 Programme (European Commission, 2012d). The NER300 Programme is one of the world's largest funding programmes for the demonstration of CCS and innovative renewable energy technologies at commercial scale within the EU, named from the early sale of 300 million allowances from the Phase 3 New Entrant Reserve (NER).

Whilst there was no limit to the use of international credits (CDM and JI) in the first Phase, none were surrendered for compliance. This is due in part to the higher price offered for the use of CER/ERUs in the second Phase, and also to the delay in the launch of the International Transaction Log, which provided the link between the CDM registry and the EU-ETS. The Log was activated in October 2008 (in Phase 2). The subsequent use of international credits was substantial, peaking in 2011, and accounting for 7% of allowances surrendered (European Commission, 2012d). This produced a surplus of unused EUAs, along with remaining international credits that had not been surrendered. Sandbag (2011) estimated that 77% of installations held excess allowances in 2011.

As may be inferred, the EUA price generated by the market has been highly volatile. In early 2006, the price was around €30/tCO_2, after which the spot price dropped to almost zero by late 2007, after the release of verified emissions data from the first two years of the Phase, and the emerging conclusion that EUA demand was well below supply. The inability to bank excess allowances into Phase 2 meant that any surplus emissions became worthless at the end of 2007. The price recovered in 2008 at the start of Phase 2, but then rapidly reduced with demand at the onset of the recession in Europe. It remained generally below €10 for the remainder of Phase 2 and into Phase 3, to consistently below €5 at the time of writing. The ability to bank allowances into Phase 3 prevented the price falling to zero towards the end of Phase 2, as had occurred at the end of Phase 1. However, the remaining low prices provide small incentive to invest in emissions reductions efforts, questioning the long-term effectiveness of this instrument.

Despite these wide-ranging issues, the emissions cap has not been breached, and therefore the primary objective of the EU-ETS is being achieved. However, there is contention as to the contribution the instrument itself had on this achievement. Laing *et al* (2013) summarised the literature and concluded the EU-ETS in Phase 1 produced emission savings in the range of 120-300MtCO_2 (around 40-80MtCO_2/year), equal to around 2-4% of total capped emissions. The change in 'business-as-usual' emissions in Phase 2, due to the financial crisis, makes estimation of the impact of the EU-ETS difficult. There is little literature assessing the attributable emissions abatement in Phase 2 (primarily due to lag in data publication). The literature that exists differs in its opinion as to whether the financial crisis or the EU-ETS itself has had a larger influence on emissions avoidance. The influence of other instruments, many of which are discussed in this paper, is also unclear.

How savings attributable to the instrument itself were achieved is a key aspect in assessing its dynamic and wider economic efficiency. A primary abatement option in the power sector has been through fuel switching, from coal to gas generation. Fuel switching has also occurred in other sectors, such as cement production, which accounts for around 8% of EU-ETS emissions and was not viewed as having any significant abatement options. However, many kilns have moved towards alternative low-carbon fuels such as waste and biomass, whilst also developing cement of lower clinker intensity, reducing process emissions (Laing *et al*, 2013). Such abatement is short term and not indicative of deep system innovation and low-carbon investment. Laing *et al*'s (2013) literature review concludes that whilst the EU-ETS is now a factor in investment, R&D and other decisions, its lack of a demanding cap, consequent low price signal (compounded by a drop in production and access to international credits), and uncertainty into the future means that it is a relatively insignificant consideration, especially in long term investment decisions. However, a high importance in short-term investment and effects such as a strong increase in corporate CCS research, were also reported. The potential for 'carbon leakage', where emissions are apparently reduced through emission-intensive industries leaving the EU to avoid the additional cost burden, was a significant concern in some areas, although there is little evidence to suggest this has materialised as a significant effect. This is unlikely to change, with the Phase 3 'benchmarking' system of allowance allocation tailored towards preventing this effect in light of increased auctioning. Other aspects such as labour costs, resource availability, access to markets and other regulatory issues appear to be far more influential issues in carbon leakage (Ellerman, Convery & De Perthuis, 2010).

In summary, despite the emissions cap certainty to 2020 (at least), dynamic efficiency is evidently low. Without some form of intervention or other influence, considering the substantial volume of allowances banked for use in Phase 3 (2 billion), the current price is expected to remain at these low, ineffectual levels towards 2020, and perhaps beyond. As mentioned, in November 2012, the Commission issued a proposal for six structural reform options to improve this situation. The options are (European Commission, 2012d):

- **Increase EU GHG reduction target from 20% to 30% by 2020.** This would have an impact wider than the EU-ETS (such as the Effort Sharing Decision, discussed later in this paper), and would require the implementation of one, or a combination of the following two options presented, in order to achieve the revised target.

- **Retiring of allowances**. A number of allowances may be permanently removed from the system in Phase 3. This would require primary legislation, but may be enacted through a separate Decision, rather than a revision of the EU-ETS Directive.

- **Early revision of the annual linear reduction factor**. The 1.74% annual reduction factor is due to change by 2025, but this may be brought forward. The impact this would have would depend on the level and timing of the change.

- **Extension of sectoral scope**. This option, whilst improving the broad economic efficiency of the EU-ETS, and by including sectors that are less strongly influenced by economic cycles and crises, may lead to reduced price volatility.

- **Limit access to international credits**. International credits account for three quarters of the projected excess allowances by 2020. By allowing no, or very limited use of such credits in Phase 4 (post-2020), and/or allowing limited or no banking of these allowances, their use should substantially decrease.

- **Discretionary price management mechanisms**. Measures such as a carbon price floor, for example, would provide for a higher price certainty and reduced volatility.

These options are currently under discussion, as are additional proposals such as linking allowance availability to economic growth and industrial output. As a temporary measure, the Commission proposed a 'backloading' of 900 million allowances, making them available in 2019-2020, rather than in 2013-2015 period, as planned. This temporarily reduces EUA supply, supposedly increasing the carbon price and encouraging early investment, without reducing the overall cap. The European Parliament initially rejected this in April 2013, but in July 2013 it accepted a revised proposal – including a provision that such a measure may only be used once.

As is clear, there have been many challenges to the feasibility of successfully implementing the EU-ETS. This may be considered natural for an instrument of such scope and ambition. Such issues may be broadly divided into 'operational' and 'political'. Operational issues include the flexibility of the instrument to respond to external effects, such as the financial crisis and the relative lack of control over the use, quality and price of international credits. Another significant issue is the incidence of windfall profits. Electricity companies, along with other sectors in Phase 1 and 2 received the majority of their allowances for free. However, it was found that there was almost 100% pass through of the opportunity cost (the income forgone from not selling these credits), from electricity generators to consumers (but also in other sectors, as investigated by Bruyn *et al* (2013)). Some estimates suggest that this may have generated additional profit of at least €35 billion for the electricity sector across the EU at the expense of the consumer, raising equity issues (Lise, Sijm & Hobbs, 2010). As full cost pass-through is likely to continue in liberalised markets, the requirement to auction all allowances in Phase 3 to the power sector aims as transferring this revenue from utility profits to government revenue. In Phases 1 and 2, the minimal revenue from what auctioning there was accrued mainly to Member State treasuries, with no required earmarking (and little occurred). For Phase 3, at least half of auction revenues (and all from aviation allowance auctions) should be used to combat climate change in the EU or elsewhere. Other issues include the occurrence of 'cybercrime', in which hackers 'stole' millions of euros worth of allowances from national registries in 2011, and instances of VAT fraud (or 'missing trader fraud'), in which the trader collects VAT from the sale of an allowance to the customer, but then does not pass this on to government in the relevant jurisdiction, costing billions in lost revenue across the EU.

Political issues have proven to be no less influential on the optimality of the EU-ETS than operational issues, and are often interlinked. As many decisions on the EU-ETS design must be reached by qualified majority (or at least with majority support), ambition and stringency

often falls to enable passage into legislation. This largely resulted in high emissions caps and the high prevalence of grandfathering over auctioning due to lobbying from industries and heavily industrial Member States, especially in the first two Phases. The initial rejection of the 'backloading' proposal, in order to reclaim an effective short-term carbon price, may be considered a result of the ideological opposition of many Parliamentarians to interference in markets and the avoidance of environmental cost burdens (despite the 'artificial' nature of the carbon market in the first place), and the desire to guard against additional cost burdens and perceived impacts on industrial competitiveness.

Administrative implementation of the EU-ETS has proven effective (despite significant investment in institutional and technological infrastructure), with the division of responsibilities between the Commission and Member States relatively clear by the third Phase. This is becoming more streamlined and efficient in Phase 3, with increasing centralisation. This may alter with any future structural changes and linking with other emission trading systems, but it is likely that any alterations would fit within or add to the current administrative framework, rather than change the current composition.

Energy Taxation Directive

The current legal framework for energy product taxation at EU level derives from Directive 2003/96/EC (the Energy Taxation Directive – 'ETD'), which came into effect on 1st January 2004. The Directive restructured and widened the scope of the EU's minimum rate tax system for energy products (previously limited to mineral oils), to all energy products including coal, natural gas and electricity. In particular, the Directive sought to (European Commission, 2013b):

- Reduce distortions of competition that existed between Member States as a result of divergent rates of tax on energy products;
- Reduce distortions of competition between mineral oils and other energy products that had not been subject to Community tax legislation previously:
- Increase incentives to use energy more efficiently (to reduce dependency on imported energy and to cut carbon dioxide emissions); and
- Allow Member States to offer companies tax incentives in return for specific undertakings to reduce emissions.

The overarching objectives of these aims were to improve the internal functioning of the market, ensure greater respect for the environment and combat unemployment by allowing Member States to redistribute increased revenues from energy taxation through lower taxation of labour. Minimum rates, framed in terms of the volume of energy carrier consumed, are laid down for products used in heating, motor fuels and the consumption of electricity. Different rates apply to commercial and non-commercial use for gas oil, heavy fuel oil, natural gas, coal, coke and electricity, and for different uses of certain energy products. Article 14 states that any energy product used to produce electricity or used to maintain the ability to produce electricity, is exempt from mandatory minima. The current key minimum commercial rates are presented in Table 3. Member States are free to set their own national rates above these minima. This is a common occurrence; unleaded petrol, for example, is only taxed at the minimum rate (€359/1000l) in Bulgaria and Romania, but reaches €740/1000l in the Netherlands. Similarly

only Belgium, Bulgaria, Latvia and Lithuania levy the minimum €21/1000l on gas oil for non-commercial heating, whilst Sweden levies over €450/1000l (whilst Luxembourg receives a derogation to apply a full tax exemption, as discussed below). The Directive states that:

'The minimum levels of taxation should reflect the competitive position of the different energy products and electricity. It would be advisable in this connection to base the calculation of these minimum levels as far as possible on the energy content of the products. However, this method should not be applied to motor fuels.'

However, in reality, rates are based on historical values in Member States, rather than relative energy content, and motor fuels are explicitly excluded from this approach. In addition, over one hundred derogations were available which allowed Member States to apply reduced rates or exemptions for specific policy purposes, largely dating back to historic legal frameworks - although most of these expired at the end of 2006. Under Article 17 of the ETD, Member States may apply up to full tax exemptions for energy products used for heating and the operation of stationary motors and machinery in energy-intensive industry, and/or when voluntary agreements, tradable permit or equivalent schemes are implemented with environmental protection or energy efficiency objectives, in order to maintain industrial competitiveness. This has been implemented in the UK, for example, under the guise of Climate Change Agreements (CCAs). Domestic heating and agriculture may also be exempt, along with other specific processes and sectors, including international aviation and shipping, and energy products used for combined heat and power (CHP) generation. Table 2 below illustrates the current minimum rates in approximate relation to energy content and CO_2 emissions, for six key energy products (European Commission, 2011a):

Table 2 - ETD Minimum Rates against Energy Content and CO_2 Potential

Energy Product	€/GJ	€/tCO_2
Motor Fuels		
Petrol	€10	€145
Diesel	€8	€100
LPG	€2	€30
Heating Fuels		
Gas Oil	€0.55	€7.5
Natural Gas	€0.1	€2.2
Coal	€0.1	€1.1

It is clear that there is no direct link between the current minima and either the energy or carbon content of the fuel. This creates distortions in the market and inefficient energy use, and often a perverse incentive to consume fuels with higher carbon content. Coal, for example, is very lightly taxed in terms of both energy and carbon content, and therefore economically favourable as a heating fuel. There exists no incentive for the use of renewables in place of fossil fuels, for both electricity (as fuels used to generate electricity are exempt, and electricity consumption is taxed at a flat minimum rate – although as other instruments such as the EU-ETS provide such incentive, the ETD is arguably justified in this approach) However, a perverse incentive exists in transport, as biodiesel is taxed at the same rate as diesel, despite lower energy content by volume.

The Commission recognises that the current approach to energy product taxation does not match with the EU's climate and energy targets (the '20-20-20' targets, discussed under the Energy Efficiency and Energy Consumption (EC&EC) landscape). As such, on 13th April 2011, the Commission presented its proposal for updating the Energy Taxation Directive in order to remove these imbalances and take into account both the energy and carbon content of energy products. Revised minimum rates would be the sum of both an energy content and carbon content component, as follows:

- **Energy Content** – For motor fuels, the minimum level of taxation would be fixed at €9.6/GJ, equal to the current rate for petrol, minus the CO_2 value discussed below. For heating fuels, a rate of €0.15/GJ would apply – equal to the current (and proposed) rate for electricity.

- **CO_2 Emissions** – a fixed value of €20/tCO_2 would apply across all products except electricity, upon which this component would not apply (the CO_2 intensity of electricity varies substantially across time and space, and is priced via the EU-ETS). The CO_2 component should also be zero for all biofuels that comply with the sustainability criteria laid down in Article 17 of Directive 2009/28/EC (The Renewable Energy Directive, discussed later in this paper).

The possibility for energy-intensive industry exemption would also be removed, although EU-ETS participants would be exempt from the CO_2 component. The rates are proposed to be realigned at regular intervals to take into account changes in their real value (the proposed minimum real value should be preserved – revised every three years against the core rate of inflation), whilst the CO_2 component should follow the evolution of the CO_2 price generated by the EU-ETS, maintaining equal incentive for abatement and preventing competitive distortion between ETS and non-ETS sectors. Table 3 below illustrates current rates, and proposed rates under the revised approach.

Table 3 - Current and Proposed Minimum Commercial Rates under the ETD

Energy Product	Current Minima	Minima proposed to be reached by 2018 (expressed in current units)
Motor Fuels		
Petrol	€359/1000l	€359/1000l
Gas Oil	€330/1000l	€390/1000l
Kerosene	€330/1000l	€392/1000l
LPG	€125/1000kg	€500/1000kg
Natural Gas	€2.6/GJ	€10.7/GJ
Heating Fuels (*& motor fuels used for purposed stated in Article 8(2) in the ETD*		
Gas Oil	€21/1000l	€57.37/1000l
Heavy Fuel Oil	€15/1000kg	€67.84/1000kg
Kerosene	€0/1000l	€56.27/1000l
LPG	€0/1000kg	€64.86/1000kg
Natural Gas	€0.15/GJ	€1.27/GJ

Coal and Coke	€0.15/GJ	€2.04/GJ
Other		
Electricity	€0.5/MWh	€0.54/MWh

National authorities are responsible for implementation of these minima (those responsible for taxation), and for collection of monies levied (DG Taxation and Customs holds Commission-level oversight). The use of revenue raised is also an issue for Member States to decide, however it is encouraged that the principle of tax neutrality is employed, via the reduction of labour taxation, with a view to job creation. Such an approach was taken in the UK, for example, with the Climate Change Levy (which transposed most of the commercial rates of ETD into national law), in which employer National Insurance (social security) contributions were reduced by 0.3%, recycling the approximate £1 billion annual revenue of the Levy back to business.

Environmental objectives of the ETD are secondary to concerns of effective operation of the single market. However, it is unlikely the ETD has thus far significantly contributed towards either objective, as minimum rates were not significantly different from existing rates when introduced in 2003, and as most Member States have taken advantage of the ability to levy higher rates, significant distortions remain. The lack of a direct price link to energy content of the products concerned does not promote efficient use between these products or energy efficiency overall. These failures are exacerbated by the exemption of energy products used to produce electricity (although this is arguably justified in the overall instrument mix), energy-intensive industry, domestic heating and agriculture in particular, from the provisions of the ETD. The remaining market distortions and production of highly varied implicit energy and carbon prices renders the ETD economically inefficient, both statically and dynamically. Such characteristics (along with the extensive initial list of derogations), heightens both political and public acceptability, and instrument flexibility, at the expense of effectiveness.

Whilst the proposal to recast the ETD has not yet come to pass, its potential effect on the instruments optimality should be discussed. Restructuring the tax with a link to both an energy and CO_2 component would substantially increase the static efficiency of the ETD, as it largely equalises minimum costs across energy products and for emissions abatement across the EU – although the ability for Member States to tax above these levels remain, reducing this effect in practice. As both components are reviewed regularly, with the real value of the energy component maintained and the CO_2 component aligned to the price generated under the EU-ETS, dynamic efficiency is also increased. This flexibility also increases the feasibility of the revised instrument. Other significant issues remain. Energy products used to produce electricity remain exempt, along with domestic heating and agriculture. However, energy-intensive industry must now comply with the newly proposed minima – but as the majority of this sector participate in the EU-ETS, and are therefore exempt from the CO_2 component, overall costs are unlikely to increase substantially – reducing the additional energy efficiency and carbon saving incentives, but maintaining cost-efficiency whilst addressing industrial competitiveness concerns.

The Commission estimates that EU CO_2 emissions may reduce by around 2% in 2020 if these changes are implemented compared to the counterfactual, accounting for 37% of the non-ETS

emission reduction required to meet 2020 targets under the Effort Sharing Decision (discussed next). This would be achieved through increased energy efficiency, reduced carbon intensity and the promotion of renewable energy (e.g. biofuels), except renewable electricity, as the minimum tax burden for electricity generation remains equal. Although, the zero-rated CO_2 component for biofuels (when in compliance with Renewable Energy Directive sustainability criteria), in ignoring associated life-cycle emissions, may prove distortive.

The revised ETD is highly administratively feasible, as infrastructure already exists, and the planned flexibility of the instrument increases economic efficiency and environmental effectiveness. If Member States recycle revenue through a reduction in labour taxes, the majority of industry will remain unaffected (although there will be 'winners' and 'losers' at the margin). With effective revenue recycling in this manner, the Commission estimates up to one million additional jobs created by 2030. However, political opposition exists to the substantial increase some energy products would experience, preventing swift progress on the proposal.

1.2.2 Energy Efficiency and Energy Consumption

Some instruments that fall under this policy landscape as illustrated in Table 1, also fall under other policy landscapes. In this instance, they are discussed under what may be considered their 'primary' landscape. Such instruments that fall under this landscape but are discussed elsewhere are the EU-ETS and ETD.

Effort Sharing Decision

The EU's Climate and Energy Package is a set of policies and measures designed to accelerate the transition to a low-carbon economy in Europe. The package contains three specific, overarching targets to be achieved by 2020 (known as the 20-20-20 targets), which form three of the five headline targets of the Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth:

- 20% reduction in EU GHG emissions, from 1990 levels
- Raising the share of EU final energy consumption produced from renewable resources to 20%
- A 20% improvement in energy efficiency from 'business as usual' projections

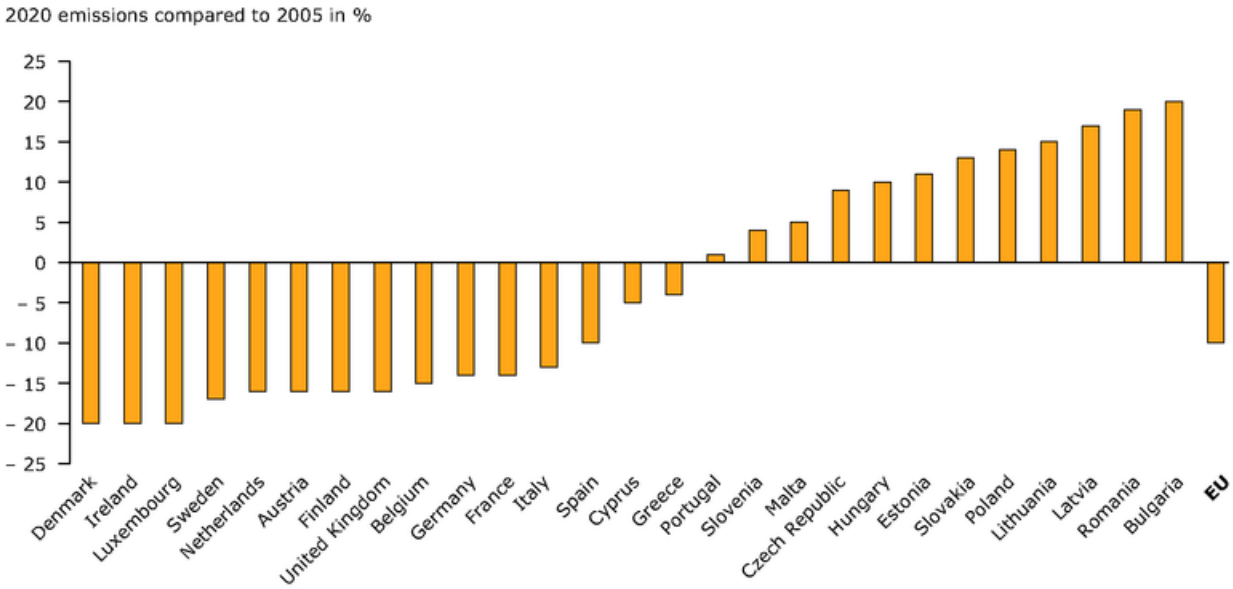
Many of the key instruments introduced to achieve these ambitions are discussed in this paper. Regarding the first target - a 20% reduction of GHG emissions in 2020 from 1990 levels - two key instruments are present. The first is the EU-ETS, discussed previously. The second is the EU's Effort Sharing Decision (ESD), introduced through Decision 406/2009/EC.

The ESD's primary objective is to oblige economic sectors not bound by existing emission reduction obligations (i.e. EU-ETS), to be so. A secondary objective is the promotion of energy security. The ESD establishes binding annual GHG emission targets for each Member State between 2013 and 2020, known as Annual Emission Allocations (AEAs). These targets include all six GHGs considered under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride), and cover most

sectors not subject to the EU-ETS, such as transport (excluding aviation), buildings, agriculture and waste. Emissions from land use, land use change and forestry (LULUCF) and international shipping are not considered**.** Figure 1 below, illustrates the proportional change in non-ETS emissions targeted in each member state by 2020, relative to 2005 emission levels.

As is clear from Figure 1, whilst all Member States have unanimously agreed and binding targets, not all are subject to a reduction. Targets are measured in tonnes of CO_2 equivalent (tCO_2e), with no sub-targets for specific GHGs. 2020 targets are based on relative wealth of Member States, measured in GDP per capita, and expected growth in the target period. As such, the least wealthy Member States may experience (limited) emissions growth in line with high projections of economic growth, whilst Member States with low GDP growth forecast should reduce their emissions. On average, by 2020, the ESD should deliver a 10% GHG emission saving from non-ETS sectors, from 2005 levels.

Figure 1 - Proportional Change Targets in Member State Emissions in 2020 from 2005 (Source: European Environment Agency, 2012)



For 2013, AEAs for Member States with limited emission growth targets do not exceed a level defined by a linear trajectory from their 2009 emissions and respective 2020 targets. For Member States with reduction targets, 2013 AEAs do not exceed their average annual emissions for the period 2008-2010. AEA allocations for 2014-2020in all Member States follow this linear trajectory. In order to increase the cost-effectiveness of the instrument, flexibility in meeting annual AEAs is permitted (European Commission, 2012e):

- **Within a Member State** – Overachievement in a given year may be carried over to subsequent years, up to 2020. Emission allocations of up to 5% during 2013-2019 may be carried forward from the following year (Article 3.2. of the Decision)

- **Between Member States** – During 2013-2019, Member States may transfer (for instance, by selling) up to 5% of their AEAs for a given year to other Member States under certain conditions (Articles 3.4 and 3.5). Any overachievement may also be traded and used by

another Member State in any obligation period. CDM and JI credits may also be used under certain conditions (Article 5), including an annual limit equivalent to 3% of total non-ETS emissions in 2005.

Member States are required to report on their annual emissions as relevant to the ESD, the use, geographical distribution and types of CDM/JI credits and criteria applied, projected progress to meeting subsequent annual targets, and planned policies and measures to meet commitments beyond those of the ESD. If a Member State fails to meet their annual obligations (once the flexibility mechanisms have been taken into account), corrective measures must be applied. A deduction of the Member State's AEA allocation for the following year shall apply, equal to the volume excess emissions (in tCO_2e), multiplied by an abatement factor of 1.08. Any flexibility mechanisms between the Member State in question and other Member States and CDM/JI shall be suspended, until a return to compliance. A corrective plan must also be complied and submitted to the Commission. DG CLIMA is responsible for the ESD at EU level, with varied national authorities responsible for different aspects and sub-instruments of the ESD at Member State level.

As the instrument only came into force in 2013, its effectiveness in achieving its objectives cannot yet be evaluated. Other aspects of optimality, similarly, may only be evaluated theoretically. As the ESD enforces binding emission limits on most non-ETS emissions, its effectiveness may be considered high. However, whilst there are penalties for exceeding annual emission allocations up to 2019 (reduced subsequent annual cap), there are no clear penalties for exceeding the final allocation in 2020. The overall environmental effectiveness of the instrument is also called into question by the European Environment Agency (2012) finding that only six Member States will be required to do more than Business as Usual (BAU), or more than policies already committed, to meet their 2020 ESD targets (Belgium, Greece, Ireland, Luxembourg, Malta and marginally, Spain). This may be considered a concession to political acceptability of the ESD itself, and of the 2020 emissions reduction target (20% on 1990 levels).

The ESD may be considered broadly statically efficient, as it imposes a high-level, broad target (although not economy-wide), under which the Member State may theoretically select the cheapest abatement options to achieve. However, this depends on the design of the 'implementing' instruments used to achieve this over-arching goal; many of which are other EU Directives (of which many are discussed in this paper), reducing this initial apparent flexibility. The exclusion of LULUCF, an emissions negative sector in the EU (GHG removal of around 9% emissions from other sectors), whilst reducing the scope of the instrument and therefore it's static efficiency, is a practical consideration for the effective functioning of the instrument.

The imposition of a national cap is less cost-efficient than a single EU-wide cap, however the flexibility mechanisms provide a limited ability to trade abatement actions across both Member States and time. Whilst the ability to trade proportions of AEAs provides them with an economic value, the imposition of heavily restricted trade (5%) prevents the imposition of a single non-ETS carbon price, in the manner of the traded sectors. The limited use of CDM/JI credits also increases cost-efficiency, however these mechanisms have well documented issues. A particular issue in respect to the ESD is the ability to use HFC23 and N_2O CDM

credits – banned for use in the EU-ETS. However, most Member States have declared they will not use such credits in meeting their obligations.

Although the existence of binding targets to 2020 and the ability to trade and therefore receive financial reward for abatement encourages dynamic efficiency, the finding that only six Member States must take additional action to meet their targets (European Environment Agency, 2012), reduces the general incentive for further abatement and incidence of innovation beyond existing rates. The inherent flexibility of broad emissions caps, along with differentiated national targets and an apparent lack of ambition for real additional emissions reductions make its implementation highly feasible, possibly at the expense of real environmental effectiveness (however, this is dependent on overarching targets that the ESD is designed to meet, rather than the ambition of the ESD alone).

Energy Efficiency Directive

Energy efficiency in the EU is increasingly seen as important from a variety of angles; including energy availability (producing 'negawatts') and security, emissions reductions, the promotion of sustainable economic growth, industrial competitiveness and job creation. This is highlighted through its inclusion in the '20-20-20' targets, the 'Europe 2020 Flagship Initiative for a Resource-Efficient Europe', the 'European Energy Strategy 2020' and the Commission Communication 'A Roadmap for Moving to a Competitive Low-Carbon Economy in 2050'.

The overarching '20-20-20' target for energy efficiency, agreed in 2007, refers to a 20% saving in primary energy consumption in 2020, equalling 368Mtoe (megatonnes of oil equivalent), against a projected baseline of 1,842Mtoe This means that primary energy consumption in the EU in 2020 should not exceed 1,474Mtoe (and, additionally, 1,078Mtoe in final energy consumption). In 2007, at the time of this target's announcement, a key instrument to encourage energy efficiency was the Energy Services Directive (2006/32/EC). The Directive's objective was to make the end-use of energy more economical and efficient by establishing indicative targets and incentives for efficiency, establishing the institutional, financial and legal frameworks needed to eliminate market barriers and imperfections that prevent the efficient end-use of energy, and by creating the conditions for the development and promotion of a market for energy services and for the delivery of energy saving programmes and other measures. Member States were required to adopt an energy saving target of 9% final energy consumption by 2016 (compared to business as usual), delivered through National Energy Efficiency Action Plans (NEEAPs). The Commission published its first report on the first round of National Energy Efficiency Action Plans (NEEAPs) in 2008. At that time many Member States had not communicated their first report. In its evaluation of the NEEAPs, the Commission concluded that while some Member States had put in place comprehensive strategies and plans to meet or go beyond their targets, many were likely to prove inadequate, and achieve a saving of only 9% in primary energy consumption in 2020. In response, in March 2011, the Commission put forward a new Energy Efficiency Plan (EEP) with the objective of introducing new, firm measures to close the gap between this projection and the stated ambition. On the 25th October 2012, the EU adopted the Energy Efficiency Directive (EED) (2012/27/EU), in order to implement key aspects of the 2011 EEP. This replaced the Energy Services Directive, and also the Cogeneration Directive (2004/8/EC). The EED follows a 'two-step approach', in which Member States must adopt binding *measures*, rather than

binding, overarching efficiency *targets*. This is largely due to resistance from Member States on the costs of financing energy efficiency improvements, the bureaucracy involved in measuring the improvements, and the lack of common methodologies to measure and report them. However, Member States must set *indicative* national energy efficiency targets, based on either primary or final energy, or energy intensity. The Commission has stated it will review these targets and progress against them by 30th June 2014, and may subsequently propose binding targets if it appears likely that the 2020 efficiency target remains unlikely to be met. The following are the key measures introduced by the EED – many of which are adapted from the Energy Services Directive.

Energy Saving Obligation Schemes

Under Article 7 of the EED, Member States are obliged to establish energy saving schemes, in which energy distributors and/or retail energy sales companies must achieve the equivalent of average annual cumulative savings of 1.5% of total sales, by volume, based on average total sales of the industry across the three-year period leading up to the 1st January 2013. The obligation period is from 1st January 2014 until 31st December 2020, and Member States have flexibility as to how and when the required savings are implemented over this period. The sales volume considered may discount sales to installations subject to the EU-ETS.

The obligation on energy distributors and suppliers may be substituted for other policy measures designed to achieve energy savings amongst final customers, provided that such instruments achieve an equivalent energy saving. Such policy measures may include, *inter alia*, energy or CO_2 taxes, financing schemes, instruments or incentives that promote energy efficient technologies and techniques, regulations or voluntary agreements, standards and norms and training and education programmes. Alternatively, obligated parties may pay in to an 'Energy Efficiency National Fund', to be used to support energy efficiency initiatives.

Public Sector Energy Efficiency

The EED, through Article 6(1), obliges Member States' central governments to purchase products, services and buildings with high energy-efficiency performance over a certain contract value, insofar as that is consistent with cost-effectiveness, economical feasibility, wider sustainability, technical suitability, as well as sufficient competition. This obligation however does not extend to public bodies at regional and local levels, which must only be encouraged to do so. Moreover, the Directive asks Member States to encourage public bodies to engage in long-term energy performance contracts that provide long-term energy savings.

Member States must ensure 3% of building stock (by floor area) owned and occupied by central government is renovated annually, from 1st January 2014, with the objective of perusing energy efficiency. Renovations must meet minimum energy performance requirements laid down by Article 4 of Directive 2010/31/EU (Energy Performance of Buildings Directive, discussed next). Buildings that currently meet this level are excluded from this obligation, along with buildings with a useful floor area of under 500m^2. This will decrease to 250m^2 on 9th July 2015. Member States may opt to fulfil this obligation, partially or in full, though other means - such as behaviour change of building occupants, as long as such measures achieve the equivalent energy savings as renovation activities. Also, as with the

obligation on energy suppliers discussed above, a payment equal to the investment required to meet these obligations may be paid to an energy efficiency national fund.

Consumer Energy Efficiency

The EED attaches crucial importance to the role consumers can play in promoting energy efficiency and energy savings. The provision of accurate energy consumption information is central to leveraging this potential. The EED specifies four measures to encourage end-user efficiency, beyond previously discussed public sector obligations:

- **Energy Audits** – Member States must promote the availability of high-quality, cost-effective, independent energy audits to all final energy consumers. Programmes must be developed to encourage SMEs to undergo such audits and to implement subsequent recommendations, and to raise awareness of the availability of audits in the residential sector. From 5th December 2015, large companies (exceeding 250 employees, with annual revenue exceeding €50 million) must be subject to an energy audit carried out in an independent and cost-effective manner, at least every four years. Enterprises that hold an energy or environmental management system (EMS), certified by an independent body according to the relevant European or International Standards (e.g. ISO14001), are exempt from this requirement.

- **Metering** – Member States must ensure that, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating & cooling, and domestic hot water are provided with competitively priced individual meters that accurately reflect actual energy consumption and provides information on actual time of use ('smart meters' – as defined by Directives 2009/72/EC and 2009/73/EC). Such a meter should be provided when a previous unit is replaced (if technically possible and financially reasonable), if a new connection is made, or a building undergoes a major renovation as set out in the Energy Performance of Buildings Directive. At the consumer's request, meters for electricity must have the ability to account for electricity delivered to the grid from the consumer's premises.

- **Billing Information** – Where final customers do not have smart meters, Member States must ensure that billing data is accurate and based on actual consumption (rather than estimated), for all final consumers where technically possible and economically justified, by 31st December 2014. This may be fulfilled through a system of regular self-reading by customers. Only when the customer fails to report this information may a supplier provide a bill based on estimated consumption, charged at a flat rate. All customers, regardless of whether a smart meter is installed, should have easy access to information regarding their consumption, such as daily consumption profiles. Such information, along with the billing information itself, should be provided free of charge (with costs recouped through general billing).

- **Consumer Information & Empowerment** – Member States must take measures to promote and facilitate energy efficiency by small energy consumers, including domestic

consumers. This may include fiscal incentives, access to grants and subsidies and information campaigns.

Supply-Side Energy Efficiency

The EED promotes two types of measures to encourage energy efficiency in the production and provision of energy. The first are measures to promote high-efficiency cogeneration and efficient district heating and cooling. By 31st December 2015, Member States must produce a comprehensive assessment of existing potential and cost-benefit analysis of the possibility of adding cogeneration to new and existing energy producing installations. The second is an obligation imposed upon national energy regulatory authorities to pay due regard to energy efficiency when carrying their regulatory tasks. In particular, network tariffs and regulations should provide incentives for grid operators to make system services available to network users, permitting them to implement energy efficiency improvement measures in the context of the deployment of smart grids. Other measures include the obligation to conduct assessments of the potential for energy efficiency improvements of energy infrastructure, the obligation to provide priority or guaranteed access to the grid of electricity from high-efficiency cogeneration, and the possibility for the latter to offer balancing services to the system.

From 30th April 2013, Member States must report annually to the Commission on progress achieved towards national energy efficiency targets. By 30th April 2015, and every three years thereafter, Member States must submit NEEAPs. NEEAPs should contain details of significant energy efficiency instruments, alongside achieved and expected savings. It should also contain updated projections of primary energy consumption in 2020, and against indicative energy efficiency targets. The Commission will review these annual reports and NEEAPs, and may issue recommendations to Member States. There are no specific penalties for Member States for non-compliance, however national authorities must devise and implement effective, proportionate and dissuasive penalties for non-compliance of the above obligations, aside from 'supply-side energy efficiency' (Article 13). DG Energy is responsible for the instrument at EU level, whilst at Member State level - due to the wide-ranging provisions of the Directive - responsibility is diffuse.

Again, as the EED is very recent, its optimality in practice is not yet clear and may only be assessed ex-ante. Success of the EED overall may be measured ex-post by primary and final energy consumption in 2020, and in the mean time by the trajectory in the intervening years. However, this is dependent on myriad other factors (population growth, demographics, GDP growth, growth or decline of energy intensive industry, etc.), and does not necessarily imply an improvement in energy efficiency (defined as the ratio of output of performance, service, good or energy, to input of energy), or where there is improvements, it is not necessarily different to the projected counterfactual or directly attributable to this instrument. Success, then, may be measured more specifically by progress against the sub-targets.

The energy saving obligation schemes will require energy suppliers to work with end users in implementing energy savings, largely through the promotion of end-use efficiency measures (insulation, double glazing, etc.). Member States have freedom to design a nationally appropriate scheme, but flexibility mechanisms mean alternative approaches may also be pursued, such as voluntary agreements or payments to energy efficiency funds. Such

measures should produce the same energy saving result; however ensuring this is difficult. If it is clear that such a measure will not deliver equivalent savings, the Commission reserves the right to refuse this course of action. Overall, the Commission estimates that this measure should reduce primary energy consumption by 6.4% by 2020 (up to 118Mtoe), if measures are of sufficient ambition and implemented properly.

A 3% renovation rate in public buildings appears achievable as such a rate currently exists on average across the EU, but only half of these renovations implemented energy efficiency improvements prior to the introduction of the EED. The Commission estimates this measure could lead to 6Mtoe savings in 2020 – a rather low value considering buildings represent 40% of the EU's final energy consumption. The EED only mandates efficiency improvements in public buildings (private buildings are considered in the Energy Performance of Buildings Directive, discussed next), and several exemptions, such as floor area considerations and the potential exclusion of historic buildings reduces the scope of application. In addition, renovations must only meet the minimum requirements of the Energy Performance of Buildings Directive. Again, opt-outs through payments into national funds or other such measures, are also a possibility. As such, the overall environmental impact of this measure appears rather negligible.

Other measures discussed, such as supply-side efficiency, energy audits and smart metering have no specific targets, so their achievement and subsequent effectiveness will be difficult to determine ex-post and estimate ex-ante. This is compounded by legislative overlap, such as the 80% smart meter rollout target for electricity contained in Directive 2009/72/EC. Whilst the EED introduces small, additional commitments, the primary driver is likely to be the pre-existing legislation.

Whilst the Commission estimates the introduction of the EED (in addition to pre-existing legislation) will deliver overall reductions in primary energy demand of between 19.7% and 20.9%, the lack of penalties for non-compliance at national level with self-imposed overall targets is small incentive for significant ambition. The only threat is the suggestion of legally binding targets from 2018, which would remain subject to acceptance by Member States. Such an acceptance is unlikely and does not provide sufficient time to ensure 2020 targets are achieved. A further barrier to implementation is the presence of regulatory and non-regulatory barriers (including 'split incentives') to the uptake of energy efficiency potential. The 2011 EEP recognised this as a priority to address – although the EED (Article 19), requires only that Member States 'evaluate' and 'take appropriate measures' to remove these barriers. However, the Commission may review progress on this aspect and put forward legislative proposals to address lack of action by 2018, if required. Despite the Commission's estimation of the impact of the EED, European Environment Agency (2013c) modelling suggests that stronger implementation of the EED's provisions and possibly additional measures will be required to meet the 2020 targets, however this depends on the rate of economic recovery in the EU.

Energy efficiency is often seen as a highly cost-effective in emissions mitigation, or even cost-negative – energy cost savings are often expected exceed the costs of implementing the measure. Indeed, the Commission estimates that energy efficiency has the potential to generate financial savings of up to €1000 per household, per year. However, the only measure in the EED with which net savings are expected with any confidence is the public sector

renovation obligation, with additional investment costs of €1.6bn against energy cost savings of €1.92bn – although this is heavily dependent on future, relatively unpredictable energy costs. Consumer energy efficiency measures (billing information, energy audits, etc.) also have the potential to produce net savings, but this is dependent on behavioural responses and interactions with other instruments (e.g. finance mechanisms), to make this possible. The energy saving obligation schemes are expected to produce a small net cost (European Commission, 2011b).

The significant flexibility afforded to Member States to implement appropriate measures and obligation adjustments to meet their broad obligations (and self-imposed targets), means the most cost-effective approach may be theoretically taken at the national level, suggesting high static efficiency. However, the specific measures included in the EED are not economy wide – transport, for example, which accounts for around 25% of the EU's primary energy consumption, may be excluded from the energy saving obligation. Depending on the specific design of national measures, the cost per unit of energy saved (e.g. €/kWh) may be vastly different between sectors and Member States. Additionally, as savings are not linked to the emission intensity of the energy saved, implicit carbon prices will also vary significantly across sectors and member states. This reduces the static efficiency of the instrument significantly. The lack of a strong incentive for energy saving into the future (above that which already exists – energy cost reduction), such as binding 2020 targets, produces poor dynamic efficiency. However, as central government is a very significant consumer in the economy, the public sector renovation obligation and energy-efficiency product purchasing should encourage the innovation and diffusion of energy-efficient technologies. The Commission estimates that this will produce further savings of 9-18Mtoe by 2020, through growing the market for these products, with a potential side-effect of job creation.

The distributional impact of the cost of the measures in this instrument depends strongly on individual design and implementation. Whilst the public sector obligation is expect to produce net savings, and the cost for energy audits will fall on the recipient, the expected net cost of energy saving obligations will fall on final consumers from all sectors through general energy billing. This may lead to low-income groups cross-subsidising others, unless provisions are put in place to target energy saving measures at these groups.

The lack of binding targets or penalty mechanisms, and the volume of flexibility mechanisms and opt-out options present in the EED, including the prevalence of measures only binding with the caveat of 'cost-effectiveness' (which may provide significant 'loop-holes' in compliance and compromise effectiveness), hints at the level of political compromise reached to allow the instrument to pass into law. There are likely to be significant administrative co-ordination challenges if the objectives of the EED are to be achieved, as measures are likely to impact many different administrative departments (energy, domestic, infrastructure, industry, etc.), however this will depend on the strength of will to implement these measures in a meaningful way, in each Member State.

Energy Performance of Buildings Directive

The original Energy Performance of Buildings Directive (2002/91EC) (EPBD) was the first instrument that took a holistic approach towards the encouragement of energy efficiency in the

European building sector; which accounts for around 40% of the EU's final energy consumption. It was introduced in order to capture the potential for emissions reductions associated with energy savings, to contribute to the EU and Member States' Kyoto targets. In response to the introduction of the '20-20-20' targets, and in order to tap the remaining significant, cost-effective energy saving potential not achieve by the original Directive, a recast EPBD Directive (2010/31/EC) was adopted on 19th May 2010. The primary objectives of this recast were to clarify, simplify and strengthen existing provisions, and to provide for the leading role of public sector.

The EPBD (hereafter referring to Directive 2010/31/EC), lays down requirements regarding six specific aspects surrounding energy use in buildings. The first is an updated common framework for a methodology for calculating building energy performance, found in Annex I of the Directive. The second provides revised provision for minimum requirements for the energy performance of buildings.

Minimum Energy Performance Requirements

Member States are required to set minimum energy performance standards for buildings, building 'units' (defined as a section, floor or apartment within a building which is designed or altered to be used separately), and elements of the building envelope that have a significant impact on the energy performance of the building when replaced or retrofitted. 'Energy performance' is calculated according to Article 3 and Annex I of the Directive, and is expressed using an energy performance indicator and a numeric indicator of primary energy use, based on primary energy factors per energy carrier (e.g. electricity). Member States are not required to set minimum standards which are not cost-effective over the economic lifecycle of the aspects in question, as determined using the comparative methodology framework described in Article 5 and Annex III of the Directive. Standards may also differ between new and existing buildings, and between categories of buildings (e.g. offices, hospitals, hotels and restaurants). These minimum requirements must be reviewed at least every five years.

For all new buildings, prior to construction the technical, environmental and economic feasibility of the use of renewables, cogeneration, district heating and heat pumps should be assessed and taken into account. For all existing buildings undergoing major renovation (when either 25% of the building envelope or 25% of the value of the building (excluding land value), undergoes renovation), minimum performance requirements should be set for the building or building unit as a whole, and/or the renovated building elements – as far as technically, functionally and economically feasible. These requirements are stricter than those contained in the original Directive, which stated that these provisions only applied to new and existing buildings with a useful floor area of over 1,000m^2. The use of renewables and high-efficiency systems is also now encouraged in the renovation of existing buildings. New provisions for technical building systems were also introduced, with Member States obligated to set requirements for the overall energy performance, installation and control of heating, hot water, air conditioning and ventilation systems in existing buildings when new, replaced or upgraded. The same requirements may also apply to new buildings. The new Directive also encourages the installation of smart metering in new and renovated buildings.

Nearly-Zero Energy Buildings

The third aspect introduced in the 2010 recast is the requirement that by 31st December 2020, all new buildings must be classified as 'nearly zero-energy buildings' (NZEBs). For all new buildings owned and occupied by public authorities, the deadline is 31st December 2018. A NZEB is a building with very high energy performance, with the remaining low energy demand covered very significantly by renewable energy.

Member States must produce national plans for achieving this goal, including interim targets for 2015 and targets for refurbishing existing buildings into NZEBs. The definition of NZEBs given above should be given a numerical indicator in kWh/m^2, based on primary energy consumption, and considering national, regional and local conditions. The Commission will evaluate these plans and publish a report on progress on increasing the volume of NZEBs every three years, beginning in December 2012.

Energy Performance Certificates

The fourth feature of the EPBD is Energy Performance Certificates (EPCs), which were a feature of the original Directive, but were revised and reinforced in the recast. Any private new building, or any private building that is sold or rented to a new tenant must be issued an EPC (which is then made available to the new owner/tenant), along with any public building with over 500m^2 and frequently visited by the public (this will decrease to 250m^2 on 9th July 2015. In the original Directive, this was 1,000m^2). In all publicly owned buildings for which an EPC has been issued using the above criteria, along with any privately owned building over 500m^2 useful floor space which is frequently visited by the public (e.g. university libraries), EPCs (or *Display* Energy Certificates – DECs – in this context), must be displayed in a prominent place, clearly visible to the public. For private buildings, the ECP must be displayed in any advertisement and sales/tenancy agreement – making the EPC a more 'active' energy label.

An EPC should include the energy performance of the building, along with reference values such as minimum requirements, in order to allow for assessment and comparison. Other information, such as the contribution of renewable energy to total energy consumption, may also be included. The 2010 recast also now require EPCs to include recommendations for the cost-effective improvement of energy performance, along with an indication of where the owner or tenant may find more information to implement these recommendations. Public authorities are encouraged to take the lead by implementing these recommendations in buildings they own and occupy. EPCs are valid for 10 years from date of issue. An example of a DEC used in a public building, is given below Figure 2. DECs are not required to display the cost-effective improvement recommendations found in the full EPC.

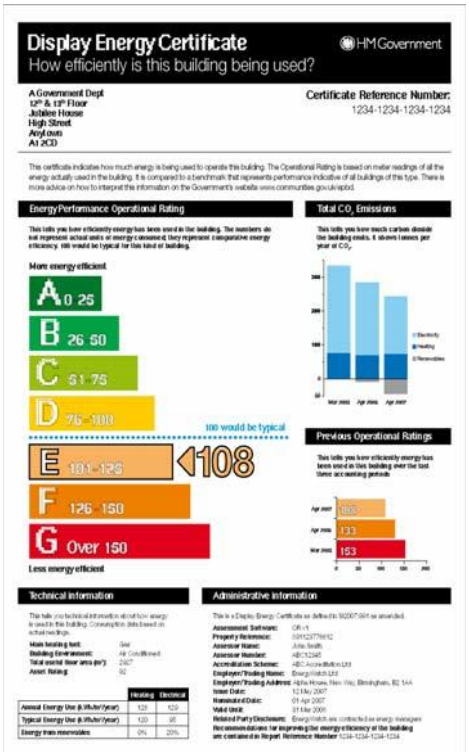
Inspection of Heating and Air Conditioning Systems

The fifth and penultimate element of the EPBD is the requirement for heating systems (heat generator, control system and circulation pumps), with an effective rated output for heating purposes of over 20kW, and air conditioning systems with an effective rated output of over 12kW, to be regularly inspected. The inspection assesses the efficiency and sizing of the system, compared with the heating and/or cooling requirements of the building. Member

States may determine the frequency of inspection, however heating systems with boilers rated at more than 100kW must be inspected at least every two years (four years for gas boilers). An inspection report containing details of the assessment, along with recommendations for cost-effective improvement of the inspected system, must be produced.

Alternatively, Member States may opt to take measures to ensure the provision of advice to users concerning the replacement and modification of heating and cooling systems, and alternative solutions to assess the size and efficiency of the systems. Such an approach should achieve the same impact as the standard approach (i.e. cost-effective energy savings).

Figure 2 - Display Energy Certificate (DEC) Example (Source: DCLG, 2012)



Independent Control Systems

The sixth and final aspect of the Directive is a new element, requiring that independent systems of control be established for the provision of EPCs and heating and cooling system inspections, to ensure quality assurance and standardisation (Article 18). This is linked to Article 17, which requires that qualified and/or accredited experts carry out both measures in an independent manner. Member States may implement individual approaches to EPC design, issuance and heating and cooling system inspector accreditation. For the EPC scheme, however, a voluntary, common approach has been adopted (as illustrated in Figure 2). Member States are encouraged to either use or recognise this approach in their national implementations.

Member States must lay down the rules for compliance along with effective, proportionate and dissuasive penalties for infringement. An evaluation of the Directive by the Commission must be produced before 1st January 2017, and proposals for amendments generated if required.

DG Energy holds central responsibility for the EPBD, with energy departments and agencies largely responsible at national level, along with local government.

The impact assessment for the recast Directive estimates annual energy savings of 60-80Mtoe by 2020 (equal to 5-6% of projected final energy demand in 2020), and an annual CO_2 reduction of 160-210MtCO_2 by 2020 (equal to 4-5% of projected emissions), if the Directive is fully implemented (European Commission, 2008). However, there are no stated energy or emission saving targets against which to measure the effectiveness of this instrument, and there is little available data to produce an assessment (both before and since the recast), and few attempts to do so in the literature. The effectiveness of the instrument may only then be assessed by its individual components.

The imposition of minimum energy performance requirements, calculated to a cost-optimal, level for each Member State using the standardised methodology provided, has proven difficult for several reasons, including the variety of the building stock and lifetimes within Member States, climate stochasticity and a lack of data with which to make informed judgements. As the actual cost-optimal point for the installation of energy efficiency measures will vary across each building, generalisations based on calculations using such information is unlikely to produce the cost-optimal level for most buildings at which to set minimum standards, and thus produce often expensive, prescriptive measures for increasing energy efficiency to a widely varying degree. The level of energy and carbon savings from existing buildings is made further uncertain by the lack of a known refurbishment rate in many Member States. EPCs work through the provision of information in order to make cost-efficient choices regarding properties to buy or rent, and how to improve energy efficiency further. For DECs, this is achieved through additional reputational drivers. This is a theoretically cost-effective mechanism to promote efficiency, but as there is significant scope for Member States to define the rules and mechanisms around EPCs (under the subsidiarity principle), the ambition of implementation and quality assurance of individual EPC differs, leading to variation in effectiveness in achieving its aims. A study by Mudgal *et al* (2013), found that in five countries with well implemented EPC schemes and high quality assurance (Austria, Belgium, France, Ireland and UK), there is a clear positive link between the rating of a property given on an EPC and the value of the property in buying and renting, varying from a 12% increase between single EPC ratings in Austria (‘C’ and ‘B’, for example), to 1% in Ireland. However, this does not demonstrate causality, as an energy efficient property is likely to have been renovated, or built to an all-round high standard, increasing the value for other reasons. Indeed, the same study indicates that in France, whilst energy efficiency is a significant factor in purchasing and renting decisions, it ranks sixth in importance. The effectiveness and cost effectiveness of the NZEBs cannot yet be clearly assessed, as a progress report has not yet been published (despite the requirement in the Directive for the first report to be completed by the end of 2012). Additionally, only fourteen Member States have submitted national plans for the implementation of the NZEB provision. As the definition of an NZEB has been left open to broad interpretation by Member States, the effectiveness and cost-effectiveness of this relatively prescriptive measure is open to question (although, this provision does not apply if the cost-benefit of measures to ensure a building is near-zero energy is negative over its lifetime). The final two provisions of the Directive – inspection of heating and cooling systems and the installation of independent control systems – are likely to produce additional modest efficiency savings, at little (if any) net expenditure.

The EPBD as a whole is broadly statically inefficient. Whilst its general scope covers all existing and future buildings in the EU (aside from exemptions of relatively minor importance, as stated in Article 4), it does not provide incentive for emissions reductions across the economy, and the inherent broad possible interpretations means that Member States apply different levels of stringency to the aspects of the legislation. This is compounded by the lack of a direct link between the Directive's provisions and emissions mitigation, therefore producing vastly different implicit carbon prices depending on plethora of factors, including the varied carbon intensity of the energy supply. However, due to the prevailing caveat of 'cost-effective measures', it is likely that many of these measures will produce negative carbon prices on average. Although, an additional issue arises in the calculation of cost efficiency, as this depends heavily on future energy prices, which are increasingly difficult to accurately predict.

Dynamic efficiency is also low, as there is little incentive to continually reduce emissions (via energy savings), as many of these provisions are minimum standards with little to no certainty on when or to how they will change. The only real incentive for continuous improvement is through that which exists outside this instrument – energy costs. EPCs/DECs may provide some small dynamic incentive, possibly through increasing the value of a property or reputational drivers. Despite this, innovation and diffusion of energy efficiency products and smalls-scale renewables may occur, reducing mitigation costs in the future. The Commission's impact assessment also estimates the creation of at least 280,000 jobs across the EU by 2020, mainly in the construction sector, certifiers, auditors and inspectors. Employment in firms producing relevant energy efficient technology is also likely to increase with demand.

The feasibility of the Directive is varied. Implementation in Member States has proven difficult, as evidenced above, as many Member States had no previous experience with energy efficiency requirements or promotional instruments in buildings, with several delays leading to bringing several infringement cases (21 at its height), despite the significant flexibility afforded to avoid such issues (at the possible expense of effectiveness). Flexibility also assists in political acceptance at Member State level, and in practical administrative and legal feasibility, especially in those states for which such an instrument holds no precedence.

Ecodesign Directive

The first Ecodesign Directive (2005/32/EC) was adopted in July 2005 to establish a framework for the setting of 'ecodesign' requirements for 'energy-using products'. 'Ecodesign' may be defined as the integration of environmental aspects into product design, with the aim of improving the environmental performance of the product throughout its lifecycle. 'Energy-using Products' (EuPs) are products that use, generate, transfer or measure energy such as boilers, computers, transformers and industrial furnaces. On 21st October 2009, a recast Directive (2009/125/EC) was adopted to extend the scope of the framework to 'Energy-related Products'; products which do not use energy but have an impact on energy use, such as windows, insulation materials and shower heads. The directive does not apply to means of transport for persons or goods (Article 1(3)). The primary objective of the Directive is to ensure the effective functioning of the internal market by requiring products to reach an adequate level

of environmental performance, and do not constitute a barrier to intra-EU trade. Increasing energy efficiency, environmental protection and energy security are secondary objectives.

Product coverage of the Directive, covering EuPs and ErPs, is highly significant in terms of final energy use. For a product to be liable for regulation (or a self-regulatory alternative, discussed below), it must represent a significant volume of sales (indicatively more than 200,000 units annually), have a significant environmental impact along with significant potential for reduction of this impact without entailing excessive costs – taking into account absence of other regulation and the presence of equivalent products with a wide range of environmental performance.

As the Ecodesign Directive is a 'framework' directive, 'implementing measures' must be introduced to specify requirements for any given product. During the preparation of an implementing measure the Commission must carry out an assessment of the environmental aspects of a representative sample of the product in question (consumption of materials, energy and other resources, emissions to air, water and soil, generation of waste material, etc.), and the potential for improvement across the lifecycle of the product (raw material selection, manufacturing, packaging, transport and distribution, installation and maintenance, use and end-of-life). Based on this assessment, the draft implementing measure may propose either specific or generic ecodesign requirements. Generic requirements aim at setting benchmarks for the product as a whole, with no specific limit values. This may include provision of information to the end-user, such as information on efficient use and disposal of the product (manufacturers must, in all cases, provide some information of the role the end-user may play in the sustainable use of the product (Article 14)). Specific requirements should be introduced for selected environmental aspects that have a significant impact, such as a limit on water consumption in the 'use' lifecycle phase of a washing machine.

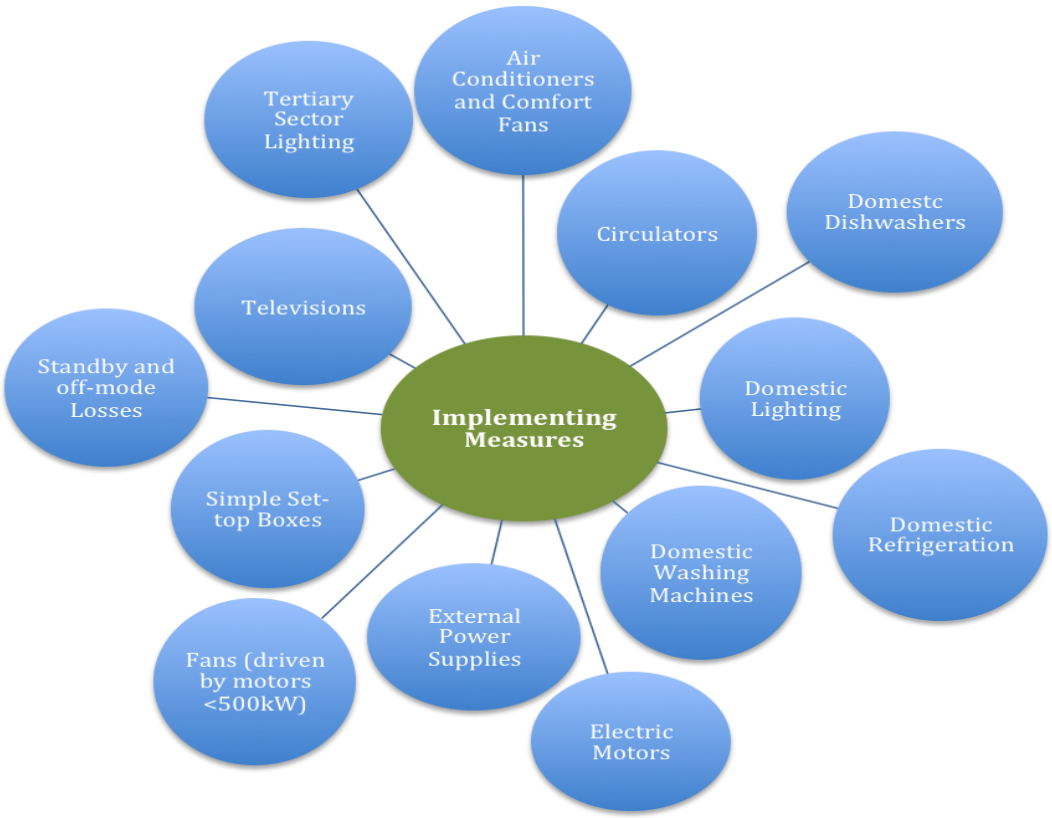
An impact assessment of the proposed measures should be carried out. The assessment should consider the overall environmental impact (taking into account existing Member State environmental legislation), the impact on manufacturers (costs and benefits, including competitiveness, innovation and market access), and the impact on consumers. The assessment should ensure that the proposed measures impose no significant negative impact on the functionality of the product, does not impact health and safety, produces no significant negative impact on the affordability and lifecycle cost of the product, and does not lead to a significant negative impact on the competitiveness or administrative burden of the industry. A 'consultation forum' consisting of a representative from each Member State, plus, *inter alia*, representatives from industry, trade unions, environmental groups and consumer organisations acts as an advisory group and contributes, in particular, to defining the working plan and priority products for attention, defining and reviewing implementing measures (and self-regulation, discussed below), examining the effectiveness of surveillance mechanisms and advising the Commission on aspects of implementation of the Directive and implementing measures.

Once an implementing measure for a product enters into force, its provisions cover all units of the specified product placed on the market and/or put into service - both domestically manufactured or imported. The responsibility in ensuring compliance falls with the manufacturer and authorised representative/importer, respectively. Products must be affixed

with the 'CE' marking to demonstrate conformity. Member States must not prohibit, restrict or impede the placing on the market or entry into service any product bearing the CE marking on the grounds of ecodesign requirements. To date, thirteen products have been subject to implementing measures (Figure 3).

The possibility for self-regulatory measures (including voluntary agreements), should be investigated, and given priority where such an approach is likely to deliver policy objectives faster and in a less costly manner than mandatory requirements. Member States must designate authorities responsible for market surveillance, which must organise appropriate checks on product compliance. When products are discovered as non-compliant, the authority may oblige the manufacturer, authorised representative or importer to recall these products from the market. The product may then be prohibited from sale until compliance is reached. Specific penalties are decided at Member State level, and must be effective, proportionate and dissuasive. Across most Member States, the most prominent responsible ministries include those for the economy and business, although energy and environmental departments are a significant minority – despite the majority most transpositions of this Directive being implemented through energy-related law (Pahal *et al*, 2013). DG Enterprise and Industry holds EU level responsibility.

Figure 3 - Ecodesign Directive - Implementing Measures



Article 21 of the Directive states that the Commission must, by 31st December 2012, review the effectiveness of the Directive and its implementing measures, and to assess the appropriateness of extending the scope of the Directive to non-energy related products. This study concluded that there is no need for an immediate revision of the Directive, either in its

current provisions or extension of its scope (CSES, 2012). However, the review also suggests that key aspects may be reviewed again in 2014 as part of the review of the Energy Labelling Directive (discussed next).

This lack of a need for revision stems from the conclusion in this review that, whilst it is too early to examine the full impact of the Directive and implementing measures, there is evidence to suggest that the objectives of free movement of goods and environmental protection are being achieved. From the available data, it is clear that products covered by an implementing measure (Figure 3) are becoming more energy efficient, and at least some of this shift may be attributable to this legislation. This is especially true for domestic and tertiary lighting in particular, due to the banning of incandescent lamps, but also for stand-by and off-modes in products and circulators in buildings through increased attention and supporting industry activities. Ex-ante assessments of the first implementing measures (Figure 3) estimate savings of 385TWh by 2020, equal to around 14% of 2009 residential electricity consumption across the EU (CSES, 2012). Despite the success of the instrument so far, as it does not address absolute levels of production and consumption of energy-related products, and may be subject to a rebound effect. Moreover, many standards may not be set at the most optimal point, as each implementing measure must be agreed by the 'Regulatory Committee', which provides voting power to each Member State based on its population. If a particularly populous nation seeks to protect its industry with a focus on the product in question, it may push for a less stringent target. The effect of such aspects, however, may be relatively small compared to the achievements of the Directive.

This instrument it is not statically efficient, as it covers only select products and has no direct link to emissions, and thereby does not necessarily promote the cheapest emissions abatement pathway. It is also relatively inefficient from the dynamic perspective, as prescriptive minimum standards are imposed, with no incentive to continue to improve beyond these levels. Although the objective of the Directive is to promote the diffusion of existing energy efficient technologies, there is evidence to suggest it has had a positive role in inducing innovation, through the provision of the necessary framework conditions, clear timetable and legal certainty to support the operation of a competitive market (CSES, 2012). This innovation is likely to produce energy savings beyond the EU, as these more efficient products are purchased around the world. The review also concludes that there have been no discernable additional costs to industry or consumers as a result of this legislation. Again, ex-ante estimates suggest overall savings between 2005 and 2020 to be around €100 billion.

The feasibility of implementation of this Directive has been proven relatively high, although some issues have been identified. It has thus far taken between four and six years to produce an implementing measure from initiation, delaying implementation and receipt of the benefits this brings. Data also may become out-dated in this time. There is also evidence of non-compliance between 10-20%, largely due to Member States failing to dedicate the necessary resources to monitoring and enforcement. Costs to the Commission and Member State administrations is currently around €400 million in total.

Energy Labelling Directive

Directive 92/75/EC (the initial Energy Labelling Directive) was adopted in September 1992 with

the objective of harmonising national measures on the publication of information on the energy consumption (and other resources) of household appliances, particularly by means of energy labelling, to enable consumers to choose more energy-efficient appliances. Directive 92/75/EC was amended several times, and was fully recast in May 2010 with Directive 2010/30/EU (hereafter referred to as the Energy Labelling Directive, unless otherwise specified). Whilst the initial Directive related to energy-using household appliances only (whether used in a domestic or commercial setting), the 2010 recast extended the scope of the Directive to potentially all energy-related products (both domestic and non-domestic), as previously defined. However, the Directive does not apply to second-hand products, or any means of transport of persons or goods.

Suppliers placing on the market or putting into service any products covered by delegated acts (which serve the same function under this framework directive as 'implementing measures' under the Ecodesign Directive), must supply a label and fiche (table of information) with the product, containing information relating to the consumption of energy (electric and other) and other resources, where relevant. 'Suppliers' in this context refers to either the manufacturer, its authorised representative in the EU or product importer. Suppliers must also produce technical documentation sufficient to enable the accuracy of the information contained in the label and fiche to be assessed - including a general description of the product, design calculations and product test reports. Suppliers must provide these labels and product information to product dealers (and competent authorities), free of charge. Dealers must then display the label on the product in the location specified in the relevant delegated act. The fiche must be available in the product brochure and literature accompanying the product (i.e. user manual).

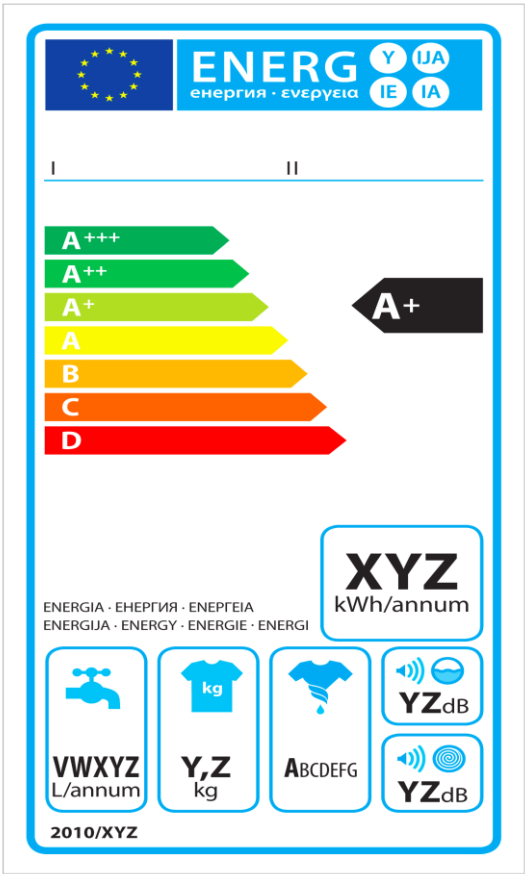
Energy-related products shall be subject to a delegated act when, considering quantities of the product available on the Union market, a significant potential for energy saving (and potentially other resources) is present, and when there is a wide disparity in energy consumption of products with equivalent functionality available. The presence of existing legislation and self-regulation (e.g. voluntary agreements) shall be considered in product priority setting, however self-regulation shall not be considered a replacement to legislation (as is possible in under the Ecodesign Direcitve). A mixture of legislation and voluntary agreements in this manner may lead to confusion, and potentially misinformation.

A delegated act should include the exact definition of the products covered, measurement standards and methods to be applied and the details of the technical documentation required for each product. It should also contain specifics regarding the design of the label to be applied, however this should have broadly uniform design characteristics across product groups, as far as possible. A typical energy label is illustrated in Figure 4.

Prior to the recast of the Directive, a product would fall into one of seven energy classes ranging from 'A' to 'G' (with 'A' the most energy efficient). In the recast, an additional three classes were made available for use (A+, A++ and A+++), in cases when a significant proportion of products available on the market achieved the two highest energy classes since a label was first introduced, and additional savings may be achieved by further differentiation. In principle, only seven energy classes should exist at any one time (i.e. if the A+++ category is in use, the lowest energy class should then be D), unless products falling into lower classes remain on the market. Similarly, the colour scale should consist of only seven colours, from

dark green to red (with dark green the highest efficiency class). If there are more than seven categories, only the red colour may be duplicated. Category definitions and metrics necessarily vary between products, and are defined by the delegated act. For example, the scale for washing machines is based on the kWh/kg load, with the 'A' classification assigned to units achieving under 0.19kWh/kg, and the 'G' rating assigned to units consuming over 0.39kWh/kg. These values are based on a cotton cycle at 60°C, with a typical load of 6kg and assuming a cold water supply at 15°C.

Figure 4 - Energy Labelling Directive - Label Example (Source: European Commission, 2010)



As demonstrated in Figure 4, additional information may be presented on the label, as relevant to the given product. Continuing the washing machine example, information on water consumption per cycle, spin-drying performance and noise emitted by the appliance (measured in decibels), are presented. As stated, each delegated act prescribes where the label should be fixed to the products, and whether or not the label should be provided on packaging, advertising and other product information material (e.g. retailer websites). All advertisements and technical promotional material must contain information on the energy label of the product. The delegated act also includes the date for its evaluation and revision, taking into account the rate and nature of technological progress. In preparing a delegated act, the Commission must take into account significant environmental aspects in the 'use' phase of a product identified in the relevant implementing measure of the Ecodesign Directive, if present, and carry out appropriate consultation with stakeholders. The Commission must also

assess the impact of the delegated act on the environment, consumers and manufacturers (including SMEs) in terms of competitiveness, innovation, market access and other costs and benefits.
Whilst the Commission has these responsibilities in preparation of delegated acts (DG Enterprise and Industry), Member States have responsibilities once these acts come into force - including ensuring all suppliers and dealers established within their territory conform with the obligations laid down in the Directive and delegated acts. In cases of non-compliance, the supplier and/or dealer must be obliged to rectify this under effective and proportionate conditions laid down by the national competent authority, within a precise timeframe. In cases of continued non-compliance, the product in question may be prohibited from sale, with the Commission and other Member States informed immediately in such cases. To ensure effective functioning of the internal market, Member States must not impede the placing onto the market or entry into service any product in compliance with the Directive and delegated acts, and should assume product compliance unless evidence to the contrary is held. Member States must submit to the Commission details of their enforcement activities and levels of compliance within their territory every four years. Competent authorities are largely the same as those discussed under the Ecodesign Directive.

Member States must also, in concluding public contracts, ensure that public authorities procure products of only the highest efficiency class whenever possible, when covered by a delegated act. Member States may also set minimum requirements on energy performance for the direct procurement of energy-related products. Both aspects are subject to cost-effectiveness considerations. A requirement also exists on Member States to run educational and promotional campaigns for energy efficiency by end-users.

By 31st December 2014, and at least every four years after, the Commission will review the effectiveness of the Directive and delegated acts, and propose amendments to the legislation if required. The first review has begun its initial information gathering exercise. A possible change, as investigated in 2012, is the extension of the label to include wider environmental lifecycle performance metrics of products (Langley *et al*, 2012). Delegated acts currently cover the following products. Additional products, such as boilers, water heaters and hot water storage, are expected to follow:

- **Refrigerated Appliances –** including refrigerators, freezers, wine coolers and combined appliances. Initial requirements were set by implementing directive 94/2/EEC, but were revised by delegated act 1060/2010, which added classes ‘A+’ to ‘A+++’ for these products. On 1st July 2014, the ‘A’ classification will change to include some products previously considered as ‘A+’. This regulation must be reviewed by September 2014.
- **Washing Machines and Tumble Dryers** - delegated acts 1061/2010 (implemented in December 2011) for washing machines and 392/2012 (implemented in May 2012) for tumble dryers replace implementing directives 95/12/EC and 95/13/EC, respectively. Both revisions introduced ‘A+’ to ‘A+++’ labels, whilst the washing machine regulation also altered the measurement approach. The washing machine regulation must be reviewed by November 2014, and the tumble dryer regulation by May 2017. Both regulations exclude combined washer-dryers, which are covered by implementing directive 96/60/EC.
- **Dishwashers** – delegated act 1059/2010, effective from September 2010, supersedes

Implementing Directive 97/17/EC, and also introduces the additional classifications, from 'A+' to 'A+++' for dishwashers, alongside altering the methodology for measuring energy efficiency in these products. This regulation must be reviewed by September 2014.

- **Ovens –** applicable to electric ovens only, Implementing Directive 2002/40/EC mandates energy labels A-G to be displayed on all relevant products.
- **Air Conditioners** – delegated act 626/2011, applicable from 1st January 2013, replaces implementing directive 2002/31/EC. The updated regulation introduces 'A+' to 'A+++' classifications in two-year intervals, beginning in January 2013, for different types of unit. Labels are present for both cooling and heating modes, where the latter is present. This regulation must be reviewed by 2018.
- **Lighting –** covering electrical lamps such as filament lamps, fluorescent lamps and LED lamps. Delegated act 874/2012, which comes into effect on 1st September 2013, replaces implementing directive 98/11/EC and introduces classes 'A+' and 'A++'. This regulation must be reviewed by 1st September 2016.
- **Televisions** – delegated act 1062/2010, which entered into force in November 2011, introduces labelling of televisions, with classifications from 'A+++' to 'G', although only seven classes may be displayed on a single label. This regulation must be reviewed by December 2016.
- **Vacuum Cleaners** – delegated act 665/2013 introduces labels to vacuum cleaners, with effect from May 2013, excluding floor polishers and outdoor devices. Labels 'A' to 'G' are initially in effect, with 'A+' to 'A+++' to be introduced in 2017, along with the application of the regulation to water filter cleaners. The regulation must be reviewed by May 2018.

Whilst there are few recent studies assessing the impact of the Directive (especially the recast), as described under the Ecodesign Directive, there is clear evidence of the increasing share of energy-efficient products. This is evidenced in the increasing use of the 'A-plus' labels, mentioned above. Whilst impact assessments have cited energy labelling as the most important factor in driving energy efficiency improvements in products in the EU (Waide & Watson, 2013), and therefore emissions abatement, the impact of this Directive as distinct from other factors (especially the Ecodesign Directive) is extremely difficult to determine. The effectiveness of this instrument in shifting the market towards more energy efficient products rests on consumer preference, and manufacturer response to this. Waide & Watson (2013) found that almost half of their multi-country respondents considered energy efficiency a key aspect in purchase decisions for products with energy labels, and most respondents found the energy labels useful in providing this information, despite some confusion with some peripheral information on different labels. Most individuals were also willing to pay significant price premiums for more energy efficient products, and many stated they would only consider purchasing products in the 'green; scale. Mills & Schleich (2010) find that a socio-economic circumstance of a household produces little difference to this effect. However, the introduction of the 'A-plus' classifications appears to introduce confusion and the feeling of diminishing returns, and weakens the impact of the label. A study by Heinzle & Wustenhagen (2010), agrees with this conclusion, meaning that the effect of consumer decisions on incentivising manufacturers to improve efficiency is likely to have weakened since the Directive recast.

As this Directive is narrow in its scope and does not provide equal abatement incentive across the economy at either Member State or EU level, it is statically inefficient. However, it

increases the provision of information to the consumer, allowing them to make more informed choices. As it is found that a significant number of households would prefer a more energy-efficient product and would be willing to pay a premium, it is likely that net monetary savings or neutral expenditure across the lifetime of the product would result, and additional net cost to either consumer or manufacturer is generally avoided (assuming full pass-through of additional manufacturing costs). Manufacturers (both within and outside the EU) are thus incentivised to produce more energy-efficient products, inducing innovation, diffusion and subsequent cost reductions, producing relatively high dynamic efficiency. However, the evidence indicating that the new 'A-plus' labels produce a lesser effect than the simpler 'A' to 'G' grading may curb this effect.

As this instrument imposes limited obligations and does not impose additional direct cost on consumers and only minimal cost to industry (Zhou, 2013), it is highly politically feasible. Costs to government for compliance monitoring are also relatively low, however of the eight Member States that currently conduct no product testing, six cite financial (along side human resources) constraints, as a key barrier (Pahal *et al*, 2013). As such, whilst manufacturer and importer compliance is reported as relatively high in general, this cannot be confirmed in a significant number of Member States. The flexibility of the instrument is also relatively low, as efficiency classifications cannot easily be redefined, or new classes added without causing potential confusion or a reduced impact.

Emission Standards for New Passenger Cars

The first comprehensive effort to reduce CO_2 emissions from passenger cars was proposed in the 1995 Community strategy to reduce CO_2 emissions from passenger cars and improve fuel economy. This strategy was based on three pillars: voluntary commitments from the car industry to reduce average emissions from new vehicles; improvements in consumer information through the labelling of all new cars; and the promotion of fuel-efficient cars via fiscal measures (i.e. tax reform). The strategy recommended an improvement of fuel economy of 25% by 2005. The European Council approved the strategy in 1996, and stipulated that the first pillar of the strategy, voluntary agreements on emissions between the car industry and the Commission, should be responsible for achieving the majority of this target. In 1998, the Commission negotiated an agreement with the European Automobile Manufacturers Association (ACEA), the Japanese Automobile Manufacturers Association (JAMA) and the Korean Automobile Manufacturers Association (KAMA). The target in this agreement was an average direct exhaust CO_2 emissions of 140 gCO_2/km for cars that would be sold in 2008. The European Parliament subsequently criticised the lack of enforcement of these voluntary agreements, and in a 2007 Communication (COM (2007) 19), the Commission proposed a mandatory approach. This approach was then adopted as Regulation 443/2009.

The objective of the Regulation is to set CO_2 emission performance standards for new passenger cars registered in the EU, in order to contribute to the EU's international and self-imposed emission reduction commitments. Cars are responsible for around 12% of the EU's CO_2 emissions, and this regulation forms a key component of both transport emission reduction efforts and emission reduction efforts as a whole. The regulation imposes a fleet-average limit of 130gCO_2/km to be achieved for new cars in 2015, to be achieved through investment and improvement in low-carbon vehicle technology. This would equal an 18%

reduction from the average 2007 new fleet carbon intensity of 158.7gCO_2/km. The overall objective of the Commission is to reach 120gCO_2/km by 2015, with the additional 10gCO_2/km to be achieved through complimentary measures, as part of the Community's integrated approach (such as CO_2 labelling for passenger cars, discussed next).

The Regulation applies to vehicles registered in the EU and defined as category M_1 in Annex II of Directive 2007/46/EC; 'vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat'. Vehicles built to accommodate wheelchair access and other special-purpose vehicles (listed in Annex II of Directive 2007/46/EC), are excluded from this Regulation. The stated limit must be achieved on average across the new car fleet of each manufacturer (at EU, rather than Member State level – and is applicable to imported as well as domestically produced vehicles), but the specific emissions target for each car is determined by a 'limit value curve', meaning that heavier cars are permitted higher emissions than lighter cars, whilst preserving the fleet average. The formula for the curve is given as follows:

$$CO_2 = 130 + 0.0457 * ((\textit{Mass of the vehicle in Kg}) – 1{,}372\text{Kg})$$

The fleet-average limit of 130gCO_2/km is being phased in between 2012 and 2015. In 2012, 65% of each manufacturer's newly registered vehicles must comply with the specific emissions target determined by the limit value curve. This increases to 75% in 2013, 80% in 2014 and finally 100% in 2015. Independent manufacturers (not part of a larger group) that sell fewer than 10,000 cars per year (and which do not wish to join a 'pool', discussed below) may apply for derogation from the specific emission target. In the application to the Commission, the manufacturer must propose an alternative target, taking into account their specific economic and technical emissions reduction potential and the market characteristics for the type of car manufactured. In addition, manufacturers that sell between 10,000 and 300,000 new cars each year may apply for a fixed target of a 25% reduction from their average 2007 average emissions. Manufacturers are also permitted to group together to form a 'pool', and act jointly to meet the target across their combined fleet. However, such an arrangement must respect competition law, and exchange of information must be limited to average specific CO_2 emissions, their specific emissions targets and total number of vehicles registered.

To incentivise the development of cars with ultra-low CO_2 emissions, each vehicle sold with emissions below 50gCO_2/km (including electric vehicles) will count as equivalent to 3.5 cars sold in 2012 and 2013, 2.5 in 2014 and 1.5 in 2015. These are termed 'super credits', and reduce the burden placed on the remainder of the manufacturer's fleet. For vehicles capable of operating on a mixture of petrol with 85% ethanol (E85), specific emissions targets will be reduced by 5% below the value calculated on the limit value curve for an equivalent vehicle until 31st December 2015, in recognition of the greater emissions reduction potential of such fuel. However, this only applies to vehicles registered in Member States in which at least 30% of filling stations provide such fuel, and when it is in compliance with the sustainability criteria set out in the relevant legislation (i.e. Renewable Energy Directive, discussed later in this paper).

Under the test procedure used for vehicle type approval, certain innovative technologies may not be able to demonstrate their CO_2 reducing effects. Such 'eco-innovation' technologies,

verified by independent certifiers, may account for additional CO_2 savings of up to 7gCO_2/km per year. Only two such technologies have thus far been approved.

For each calendar year beginning on 1st January 2010, the designated competent authority in each Member State must collect data regarding each new passenger car registered within its territory including its specific CO_2 emissions and other data listed in Annex II of the Regulation (amended in April 2013 to expand its scope). This data is provided to the Commission, who in turn keep a central, publically available register of this data and calculate the average specific emissions of CO_2 in the preceding year, the specific emissions target for the preceding year, and the difference between the two values for each manufacturer. From 2012, when average emissions exceed the target, the manufacturer (or in case on a 'pool', the pool manager), must pay an excess emissions premium for each car registered. This equals €5 for the first gCO_2/km over the limit, €15 for the second, €25 for the third and €95 for each gCO_2/km above this, for each vehicle registered. DG CLIMA is responsible for this instrument at EU level, whilst at Member State level responsibilities largely rest with environment or transport departments, or executive bodies thereof.

Although the Regulation primarily deals with achieving 130gCO_2/km average emission intensity from passenger cars by 2015, Article 1 states that the Regulation shall also impose a target of 95gCO_2/km by 2020 (equal to a 40% reduction from 2007 average new fleet intensity). By the 1st January 2013, the Commission was required to produce a review of specific emission targets and derogations, with the aim of defining the modalities for reach this target in a cost-effective, sustainable and socially equitable manner, whilst respecting competition regulations. This culminated in a legislative proposal published in July 2012 (COM/2012/393), which includes the following key provisions (European Commission, 2012c):

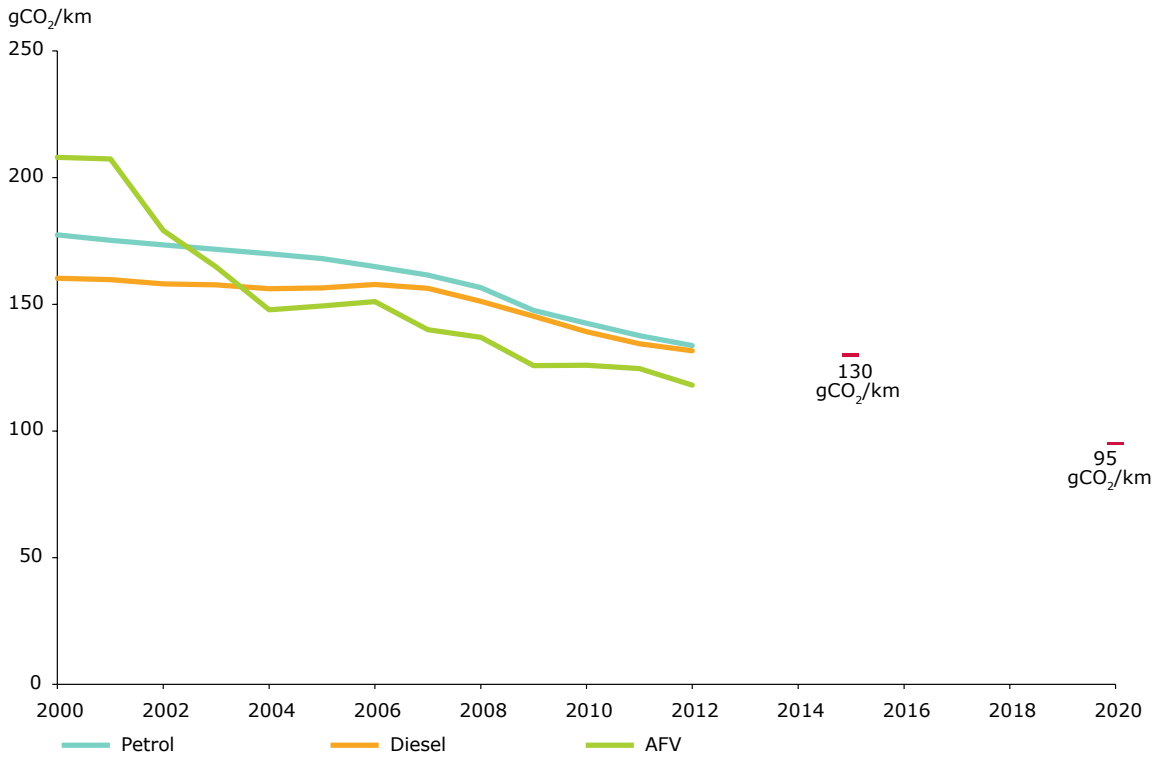
- All manufacturers would be required to achieve the same level of reduction (27%) from the 2015 target, by 2020.
- The target would continue to be set based on a vehicle's mass.
- Eco-innovations would continue to apply once the new test procedure for vehicle type approval is in place.
- Super-credits will be removed in 2016, but would return with multiplier of 1.3 in 2020-2023 for vehicles emitting less than 35gCO_2/km, limited to a maximum of 20,000 cars per manufacturer over the period.
- The excess emissions premium would be a flat rate of €95 for each gCO2/km exceeded, per vehicle, from 2019.
- Small-volume manufacturers would be given greater flexibility when applying for their own reduction target.
- The smallest manufacturers (fewer than 500 sales per year), would be exempt
- Niche manufacturers would receive a new target for 2020 of a 45% reduction from their 2007 level.
- The regulation would be reviewed by the end of 2014, in order to set reduction targets for post-2020.

This proposal is currently under debate, and whilst a preliminary deal has been agreed (including a confirmation of the 2020 95gCO_2/km target), it is still subject to a vote in the

European Parliament. Figure 5 below illustrates the trend in CO_2 emissions intensity of newly registered passenger cars in the EU, by fuel type (AFV = Alternative Fuel Vehicle).

The latest monitoring report (European Environment Agency, 2013a) indicates that average CO_2 emissions from new cars registered in 2012 was 132.2gCO_2/km, down 2.6% from 135.7gCO_2/km in 2011. This trend, as highlighted in Figure 5, indicates that this trajectory is on track to achieve both the 2015 and 2020 targets. Alongside reduced emission intensity in vehicles of all fuels, decreasing engine capacity (around 5% since 2007) and increasing dieselisation (31% in 2000 to 54.9% in 2012), have contributed significantly to this trend, despite increasing average vehicle mass (European Environment Agency, 2013a). It appears the objective of the Regulation is thus being achieved. However, the introduction of the Regulation in 2009 in place of voluntary agreements (and its announcement in 2007) appears to have little impact on the overall trend from 2000. It is therefore difficult to determine the impact the Regulation has had in practice, and there is little evidence of this in the literature. Regardless, the instrument does not tackle absolute demand for vehicles and travel, and thus has relatively limited influence over absolute emissions from this sector.

Figure 5 - Trends in Passenger Vehicle CO_2 Emission Intensity (Source: European Environment Agency, 2013a)



The static efficiency of the instrument is relatively high, as it allows manufacturers to meet their obligations in the most cost-efficient manner available to them, however as it does not incentivise emissions reduction across the economy, it cannot be considered fully statically efficient. As this instrument considers only direct emissions from cars, electric vehicles are considered to have zero emissions. There is no direct incentive to improve the efficiency of these and other 'super credit' vehicles, which is likely to become a significant issue as

registration of these vehicles increases from the 2.2% share experienced in 2012. Such an increase would in turn reduce the incentive to reduce emission intensity in conventional fuel vehicles, as the fleet average would be increasingly weighted toward zero-emission vehicles. As such, the dynamic efficiency of the instrument is reduced, in terms of continued incentive for improvements in vehicle type, but also overall as no incentive to exceed the stated 2015 and 2020 targets exists. However, the innovation and diffusion of efficient vehicles and technologies is likely to reduce abatement costs from this sector in the future.

Political acceptability of the current Regulation appears relatively high. However, Member States with a significant car manufacturing industries, especially Germany, have been active in discussions to reduce ambitions for emission standards in 2020 and beyond, on the basis of perceived discrimination between the types of vehicles produced by different manufacturers. Public acceptability is also high, likely due in part at least to a lack of awareness, but also due to the likely fuel cost savings. It is difficult to determine the impact of this instrument on vehicle capital cost, however car price reductions have accelerated since the announcement of the Regulation in 2007 (Varma *et* al, 2011), indicating that if this instrument induced a cost increase, it was overwhelmed by factors working in the opposite direction. Administrative feasibility appears extremely high, with completeness rates for mandatory reporting parameters at 99.7% for mass and CO_2 emissions, and 99% for vehicle type, variant and version (European Environment Agency, 2013a).

CO_2 Labelling for Passenger Cars

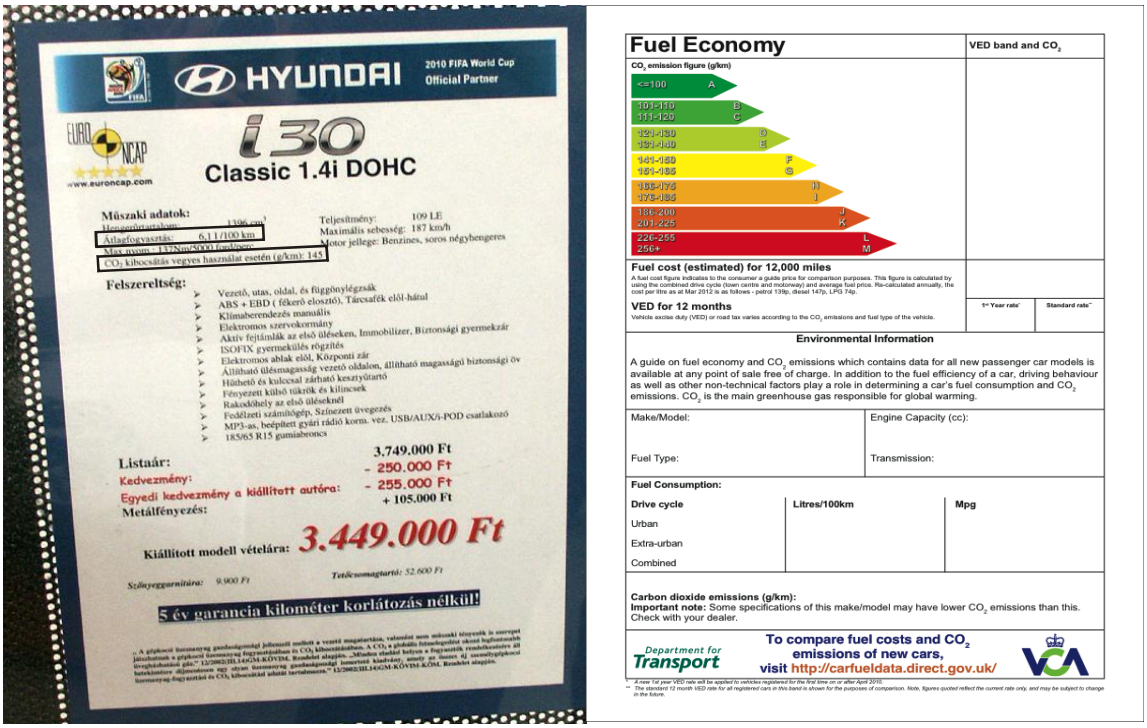
The second pillar of the 1995 Community strategy to reduce CO_2 emissions from passenger cars and improve fuel economy is an improvement in the provision of consumer information. Directive 1999/94/EC on the CO_2 labelling of cars came into effect on 21st November 2001, and attempts to achieve this. The purpose of this Directive is to ensure that information relating to the fuel economy and CO_2 emissions of new passenger cars offered for sale or lease in the EU is made available to consumers to enable them to make an informed choice, and thus encourage manufacturers to take steps to reduce fuel consumption of the cars they produce. Member States must ensure that a label on fuel economy and CO_2 emissions is attached to each new passenger car (category M_1 in Annex II of Directive 2007/46/EC, as defined previously), at point of sale (or lease), or displayed nearby. The sale or lease of used cars is excluded from these requirements, but may be voluntarily applied (as in the UK, for example). Annex I of the Directive lists the minimum requirements of the label, including:

- Comply with a standardised format within each Member State (but not necessarily Community-wide).
- Contain the numerical value of the official fuel consumption of the car to which the label is attached (expressed in litres per 100km (l/100km), or variations of magnitude), and the specific emissions of CO_2 (expressed in grams per kilometre (gCO_2/km)). CO_2 emissions for electric cars should be displayed as zero.
- Contain the text ‘A guide on fuel economy and CO_2 emissions which contains data for all new passenger car models is available at any point of sale free of charge’

- Contain the text ‘In addition to the fuel efficiency of a car, driving behaviour as well as other non-technical factors play a role in determining a car’s fuel consumption and CO_2 emissions. CO_2 is the main greenhouse gas responsible for global warming’.

Figure 6 below illustrates two example labels implemented in Hungary and the UK. Whilst both meet the requirements of the objective, it is clear separate approaches have been taken. The label on the left (Hungary) follows a text-based approach, whilst the example on the right (UK), follows a design similar to the Energy Labelling and EPBD Directives (although the UK only adopted this approach in 2005). Several countries take a similar, but slightly varied approach. For example, bands may be set relative to specific emissions of cars of the same type (e.g. Germany and Spain), whilst others set an ‘absolute’ banding, comparing a specific vehicle’s emissions against all other cars on the market (e.g. UK, France, Denmark). Member States may include more information on the label than mandated in the Directive. The UK, for example, also provides information on miles per gallon, approximate fuel cost for 12,000 miles driven, and the annual Vehicle Excise Duty (road tax) applicable to the vehicle.

Figure 6 - CO_2 Label Examples - Hungary and UK (Source: AEA, 2011)



Information on fuel economy and specific CO_2 emissions must also be provided in all printed promotional literature. A poster or display must also be present at each point of sale, listing all new cars offered for sale (or lease), with their respective fuel economy and specific CO_2 emissions. As indicated, Member States must ensure that a guide on fuel economy and CO_2 emissions is produced in consultation with manufacturers at least annually, containing a full listing of all new car models available in the Member State grouped by fuel type (petrol, diesel, etc.), with their corresponding fuel and CO_2 performance. The ten most efficient models should be given prominent listing, and information on correct use and maintenance of the vehicle, along with the impact of driving behaviour, the effects of greenhouse gas emissions and climate change, and reference to the Commissions’ average CO_2 emissions target for

passenger cars (discussed above), should be present. This must be provided free of charge at point of sale, and available from the Member State's designated competent authority.

Member States must apply nationally applicable penalties for breaches of these provisions, which must be effective, proportionate and dissuasive. Many Member States have not imposed specific penalties for infringement of this Regulation, but instead rely on existing national laws (e.g. competition law). Competent bodies and their enforcement approaches vary significantly between Member States. In the UK, for example, the competent body is the Vehicle Certification Agency (VCA - an agency of the Department for Transport), along with Trading Standards. In France, it is the General Directorate for Competition Policy, Consumer Affairs and Fraud Control (DGCCRF), and in Germany it is the responsibility of the Bundeslander (regional government). Both the UK and France use unannounced showroom visits as a key tool in enforcement, whilst Germany uses legal challenges brought by competitors, consumers or business groups, rather than proactive enforcement activities (AEA, 2011). DG CLIMA is responsible for this instrument at EU level.

By the end of 2003, each Member State was required to submit a report on the effectiveness of the Directive within their territory (14 had submitted by 31st December 2014). This was used to inform a review undertaken in 2005 on the effectiveness of the overall legislation. The results of this study are discussed below in respect to optimality of the Directive, however the report recommended several amendments to improve effectiveness. The 2007 Communication (COM (2007) 19), which proposed a revision of emissions standards to a mandatory approach (discussed above), also called for an amendment to this Directive to enact these recommendations. This was followed by a Resolution later in the year with additional detail (2007/2119(INI)). Whilst this proposed amendment has not yet been produced, the key proposals are:

- **Label Harmonisation** – The format of the label should be harmonised, along the lines of the Energy Labelling Directive, introducing standardised energy efficiency classes ('A' to 'G'), as enacted by some Member States discussed above. Classes may either be 'absolute' or 'relative', or potentially a combination of elements from each approach.
- **Running Costs and Tax Levels** – It is proposed that the average annual cost of fuel, based on the average annual driving distance in the Member State in question, along with the level of vehicle tax (also likely to be based on CO_2 emissions, as the third pillar of the initial 1995 strategy on car emissions), should be present on the label. Whilst this doesn't represent the full cost of running a car (which would include insurance, etc.), it may have an additional impact on purchase decisions.
- **Guide on Fuel Economy and CO_2 Emissions** – It is proposed that this guide is made available in a digital copy only.
- **Poster/Display** – Whilst a display/poster at point of sale, detailing the characteristics of the vehicles available at that location is currently mandatory, it is proposed that this should become a voluntary tool.
- **Promotional Literature** – At present there are only non-binding recommendations on the internet and other computerised media (stemming from Commission Recommendation 3003/217/EC on the application of other media of the provisions of Directive 1999/94/EC

concerning promotional literatures). Possible mandatory requirements for non-print media may be introduced.

- **Expansion of Scope** – extension of the requirements of this Directive to light-duty goods vehicles (N1 - vehicles designed and constructed for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes), and potentially heavy-duty vehicles. The extension of the scheme to used cars may also be considered.

The 2005 summary assessment (Gartner, 2005) concluded that by that time there had been no noticeable effect on consumer purchase decisions resulting from this instrument. AEA (2011) and Codagnone *et al* (2013) both suggest a continued lack of a noticeable effect. This largely results from the relatively low importance placed on environmental concerns by the general populous when making a car purchase decision; in a survey conducted by Codagnone *et al* (2013), it ranked eleventh, after aspects including price, safety and performance. This lack of priority is compounded by a lack of awareness of the labels, and even when this exists, a lack of understanding is also evident. For example, the above-mentioned survey found that many respondents confused the label as symbolising reliability. As the amendments proposed have not entered into force they cannot be assessed for effectiveness, however it is likely that some alterations, especially the provision of additional information such as annual fuel cost, would raise the understanding and effectiveness of the Regulation.

This instrument has low static efficiency, due to its narrow scope. In practice, it is also dynamically inefficient, as the lack of importance and awareness fails to influence purchase decisions, and therefore removes the incentive for innovation and diffusion of these technologies, and the side effects this produces. Political acceptability is high, owing to the minor nature of the regulation and its impact on manufacturers and consumers. In 2003, the European Court of Justice (ECJ) found against France, Italy and Germany for failing to transpose the Regulation. However, administrative feasibility also appears high, as there are increasingly low levels of reported non-compliance (Gartner, 2005). However, this may be due to a lack of regular and standardised monitoring in many Member States.

1.2.3 Promotion of Renewable Sources of Energy

Some instruments that fall under this policy landscape, as illustrated in Table 1, also fall within other policy landscapes. In this instance, they are discussed under what may be considered their 'primary' landscape. Such instruments that fall under this landscape but are discussed elsewhere are the EU-ETS, Effort Sharing Decision, Energy Performance of Buildings Directive, Emission Standards for Passenger Cars and CO_2 Labelling for Passenger Cars. The CCS Directive is discussed under this landscape, as despite not directly being an instrument to promote the use of renewables, it is a low-carbon technology support mechanism.

Renewable Energy Directive

The Renewable Energy Directive (RED) (2009/28/EC) is the key instrument in the second pillar of the '20-20-20' targets – 'Raising the share of EU final energy consumption produced from renewable resources to 20%', and states this as its explicit objective. It establishes a common framework for the promotion of energy form renewable sources. To this end, it establishes a number of sub-instruments and requirements. Article 2(a) defines renewable

sources as wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.

National Renewable Energy Targets & Action Plans

Each Member State has a binding target to ensure a certain proportion of their gross final energy consumption in 2020 (from electricity, plus energy for heating, cooling and transport), is obtained from renewable sources. The average of these targets is 20%. Each Member State target takes into account its share of renewable energy in 2005, modulated to reflect efforts made in preceding years. 5.5% is then added to this modulated value for each Member State. The remaining effort required was then weighted according to each country's GDP and population, in order to produce nationally appropriate target efforts to achieve the overarching goal. The resulting targets are presented in Table 4, with actual 2005 proportions of renewable provision. As a sub-target, all Member States must also ensure that at least 10% of final energy consumption in all forms of transport is from renewable sources within their territory, by 2020.

Table 4 - Renewable Energy Directive - National Targets

Member State	Share of Renewable Resources in Gross Final Energy Consumption, in 2005	Target Share of Renewable Resources in Gross Final Energy Consumption, in 2020
Belgium	2.2%	13%
Bulgaria	9.4%	16%
Czech Republic	6.1%	13%
Denmark	17%	30%
Germany	5.8%	18%
Estonia	18%	25%
Ireland	3.1%	16%
Greece	6.9%	18%
Spain	8.7%	20%
France	10.3%	23%
Italy	5.2%	17%
Cyprus	2.9%	13%
Latvia	32.6%	40%
Lithuania	15%	23%
Luxembourg	0.9%	11%
Hungary	4.3%	13%
Malta	0%	10%
Netherlands	2.4%	14%
Austria	23.3%	34%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovenia	16%	25%
Slovak Republic	6.7%	14%

Finland	28.5%	38%
Sweden	39.8%	49%
United Kingdom	1.3%	15%

Article 4 of the Directive states that all Member States must adopt a National Renewable Energy Action Plan (NRAP), which sets indicative national sub-targets for the share of energy consumed from renewable sources in electricity, heating, cooling and transport in 2020, taking into account the effects of other policy measures (including energy efficiency). It should state any existing or planned renewable support schemes (e.g. feed-in tariffs), information and training schemes, national plans to develop biomass resources, projects and co-operative measures with other Member States and methods of satisfying other obligations laid down in the Directive, and discussed in the following paragraphs. The volume of renewable electricity, gas and hydrogen used in final consumption in the sectors above should be taken into consideration, along with the use of biomass that meets the sustainability criteria laid down in Articles 17-19, and discussed in a following sub-section.

Member States must ensure that any support schemes offered are well publicised through awareness-raising and training campaigns, and information is made available to all relevant actors including consumers, builders, installers, architects and suppliers of equipment and vehicles. The technical specification of renewable technologies qualifying for a given support scheme must also be clearly defined. Information on the benefits, costs and energy efficiency of equipment and systems for heating, cooling and renewable electricity must also be made available from the supplier of the equipment or system, or by the national competent authority. Member States must ensure a certification scheme for installers of microgeneration technologies (e.g. small-scale biomass and solar PV), is established, and a list of certified installers is made public. Each Member State must recognise certification awarded by another.

Member States are able to engage in joint projects with other Member States and third party countries, and also take part in 'statistical transfers'. A statistical transfer is when a specified amount of renewable energy is generated in one Member State but consumed in another. This consumption then counts towards achieving the target of the consumer state, but not the producer. Member States may also invest in joint renewable energy projects (with or without private investors), and must state the proportion of generation to be counted towards compliance of each country involved. Member States may also engage in transfers and join projects with non-EU states for renewable electricity, as long as the electricity produced is consumed in the Community, produced by a newly constructed installation (after June 2009), and does not benefit from any other support (i.e. subsidies), other than investment aid granted to the installation. Member States may also join or partly co-ordinate national renewable support schemes. In such cases, renewable energy generated in one Member State may count towards the target of another if a statistical transfer is undertaken, or a 'distribution rule' is agreed between participating Member States, in which an agreed proportion of generation is allocated to the targets of each participant.

As well as the overarching 2020 target for each Member State, an indicative individual trajectory from 2005 levels to 2020 targets has also been determined for each country. The trajectory is not linear, but weighted towards the future to reflect technological developments

and cost reductions over time. Any Member State that falls below this trajectory for two successive years must submit a revised NRAP, detailing measures to correct this.

Member States must also detail in the NRAP how national regulations, procedures and codes are to be aligned to the goal or renewable energy promotion. Rules governing authorisation, certification and licensing of renewable installations (including spatial planning) must be objective, transparent and proportionate, and should take into account the particularities of individual technologies. The procedure should not discriminate between applicants, and information on the application process and sources of available assistance must be made available. The division of responsibility between national, regional and local authorities must be clear and transparent, with administrative processes streamlined, including less burdensome processes for smaller projects and decentralised installations.

Member States must make efforts to ensure the use of renewable technologies is considered when planning and building residential or industrial buildings or areas. This should be reflected in building regulations, and by 31st December 2014, Member States should require a minimum level of energy from renewables in all new buildings, and existing buildings subject to major renovation, and implement mechanisms to allow this to be achieved (whilst considering existing legislation and support mechanisms).

Guarantees of Origin

Member States must ensure that a 'Guarantee of Origin' (GOO) may be issued for each unit (MWh) of renewable energy produced. This allows energy generators and suppliers to prove to final customers (and competent authorities, in case of such requirements), that a given proportion of their consumption was sourced from renewables. Whilst GOOs have no function in determining compliance with a country's compliance with their 2020 targets or annual trajectory, they may be used to facilitate statistical transfers. The provision of GOOs was originally required under Directive 2001/77/EC, which was repealed and replaced by the Renewable Energy Directive.

Member States must delegate appropriate competent authorities to supervise the electronic issuance, transfer and cancelation of GOOs, and to ensure information contained within a GOO is accurate, reliable and fraud resistant. This includes mechanisms to ensure that only one GOO is produced for each MWh of renewable generation. A GOO issued in any given Member State must be recognised in any other, and must contain a unique ID number, information relating to the source from which the energy was produced, the date of production, the type of energy (electricity, heating or cooling) and details of the generating installation.

A GOO must be cancelled where the production of energy covered by this guarantee receives financial support or payment, where the energy produced is taken into account for assessing compliance with a renewable energy obligation (although not compliance with this Directive), or where an energy supplier or consumer chooses to use it for the purpose of proving the share or quantity of renewable energy in its energy mix. A GOO expires automatically 12 months from the production date of its corresponding energy unit. As GOOs are goods created by EU law, they have a market value, and are therefore subject to rules on the free movement of goods.

Guaranteed Access to the Grid

In order to accommodate the increasing production of electricity from renewable sources, Member States must take appropriate steps to develop transmission and grid infrastructure, intelligent networks and storage facilities, including interconnection between Member States and third countries. The need to extend the existing gas network to integrate the production of gas from renewable sources should also be considered.

Transmissions and distribution system operators must guarantee connection to the grid for electricity produced from renewables. This generation should also be given priority for dispatch, in so far as the security of the national grid system is guaranteed. Market-related operational measures should ensure that renewable generation is not excessively discriminated against for the objective of grid security, including the prevention of discriminatory tariffs.

Biofuel Sustainability Criteria

The 2003 Biofuels Directive (2003/30/EC), introduced a set of measures to promote the use of biofuels as alternative fuels for road transportation. The instrument had the dual objective to increase energy security in the Community and to reduce CO_2 emissions. In particular, the Biofuel Directive obliged Member States to set targets for the share of biofuels in transport of 2% in 2005, and 5.75% in 2010. The Renewable Energy Directive repealed the Biofuels Directive, and expanded this 2010 target to 10% of energy consumption in transport to be from renewable sources by 2020. Whilst this target may be satisfied through the use of other renewable fuels, biofuel is likely to account for the majority of compliance. Biofuel, for the purposes of this Directive, is any liquid or gaseous fuel for transport produced from the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industry, and the biodegradable fraction of industrial and municipal waste. The contribution of biofuel from waste, residues, non-food cellulosic material and lingo-cellulosic material is considered as double that made by other sources, in terms of target compliance.

Concerns have been raised over the sustainability of biofuels produced for consumption in the EU, including the destruction of biodiversity and the impact on crop composition and subsequent impacts on food prices. The RED attempts to ensure the use of biofuels does not contradict other environmental and social goals through the imposition of biofuel sustainability criteria. For biofuel to be eligible for use in meeting national targets and for receiving benefits under support mechanisms, these criteria must be met. The criteria may be summarised into three key points, and apply to biofuels sourced both within and outside the EU:

- **GHG emission saving from the use of biofuels should be at least 35%** when compared to conventional fuel, based on standard values for a production pathway or calculated as the result of a standardised methodology, both of which are detailed in the Directive. From 1st January 2017, this will increase to 50%, and subsequently to 60% on 1st January 2018. Biofuels produced from waste products must fulfil only this criterion.
- **Biofuels should not be obtained from raw material produced on land with high biodiversity value**, such as primary forest, other wooded land or highly biodiverse

grassland, where there is clearly no visible indication of human activity and the ecological process are not significantly disturbed, or any land protected by law for the preservation of nature.

- **Biofuels should not be obtained from raw material produced on land with high carbon stock**, such as wetlands and continuously forested areas. The use of raw material obtained from peatland is also prohibited, unless evidence is provided to show that cultivation and harvesting of the raw material did not involve the drainage of previously undrained soil.

Biofuel suppliers, on request from a competent authority, must submit independently audited information and data used to prove a given volume of biofuel meets these criteria. The Member State is then responsible for ensuring the quality of this information and therefore the sustainability of the biofuel used to meet its targets – subject to potential further verification by the Commission. The Commission shall also endeavour to enter bilateral or multilateral agreements with non-EU states, under which biofuel produced an imported to the EU meet these criteria. Any standardised national verification schemes within Member States, or any other voluntary agreement scheme, may be approved by the Commission as robust in ensuring biofuels meet these criteria, subject to adequate transparency and independent auditing. Fourteen voluntary schemes are currently recognised. Member States must recognise verified biofuels under these schemes, when approved by another Member State.

Each Member State must report to the Commission on aspects for which they bear responsibility, every two years (from 2011 to 2021). This includes progress towards the national targets and provisions of the Renewable Energy Directive, specifically the overall share of energy produced from renewable sources (also by sector), compared to the calculated trajectory, the operation of support schemes, the functioning of GOO mechanisms, improvements in grid infrastructure and access and the use and impact of biomass. The administrative infrastructure used to deliver Member State responsibilities should also be presented and its effectiveness assessed. The Commission, in turn, must report on the overall progress of the Directive and its provisions, based on Member States reports, every 2 years (the first report was published in 2011). It must also report on the environmental and social impact of the increased demand for biofuel production in non-EU countries; including the impact on food prices, respect for land-use rights, and whether relevant countries are implementing various International Labour Organisation conventions. The effectiveness of the sustainability criteria should also be reported. If aspects of the Directive implementation are found to be ineffective, The Commission may propose corrective action. The final review to be conducted in 2021, as currently envisaged, will conduct a full ex-post assessment of the Directive. DG Energy is the responsible Commission body for this instrument, whereas similarly to previous instruments, a variety of national competent authorities are employed across Member States.

Whilst the Directive imposes no defined penalties for non-compliance by Member States in either transposing the Directive into national law, or carrying out responsibilities discussed, it is able to bring legal action against Member States for failing to fulfil legal obligations under existing EU law (Article 259 of the Treaty of the Functioning of the European Union). As the Directive also fails to specify penalties upon other actors for failing to deliver upon obligations, Member States are obliged to set penalties to ensure national obligations are reached.

In March 2013 the Commission published its second progress report on the Directive, which focuses largely on the latest available data from 2010. It reports that twenty-four Member States had already equalled or exceeded their first interim target (average of 2011/2012 RES shares) by 2010, including the EU-wide interim target of 10.7%, as the 2010 average share equalled 12.7% of energy consumption sources from renewables. Table 5 presents 2010 data for all Member States against their first interim targets (European Commission, 2013a).

Table 5 - Renewable Energy Directive Progress (Source: European Commission, 2013a)

Member State	Share of Renewable Resources in Gross Final Energy Consumption, in 2010	1st Interim Target Share of Renewable Resources in Gross Final Energy Consumption, Average of 2011/2012
Belgium	5.4%	4.4%
Bulgaria	13.8%	10.7%
Czech Republic	9.4%	7.5%
Denmark	22.2%	19.6%
Germany	11%	8.2%
Estonia	24.3%	19.4%
Ireland	5.8%	5.7%
Greece	9.7%	9.1%
Spain	13.8%	10.9%
France	13.5%	12.8%
Italy	10.4%	7.6%
Cyprus	5.7%	4.9%
Latvia	32.6%	34%
Lithuania	19.7%	16.6%
Luxembourg	3%	2.9%
Hungary	8.8%	6%
Malta	0.4%	2%
Netherlands	3.8%	4.7%
Austria	30.1%	25.4%
Poland	9.5%	8.8%
Portugal	24.6%	22.6%
Romania	23.6%	19%
Slovenia	19.9%	17.8%
Slovak Republic	9.8%	8.2%
Finland	33%	30.4%
Sweden	49.1%	41.6%
United Kingdom	3.3%	4%
EU	**12.7%**	**10.7%**

It would then seem that the Directive is effective in achieving its overarching objective. However, despite this overall promising picture there are underlying difficulties. Fifteen Member States failed to meet indicative 2010 targets for renewables in the electricity sector,

and twenty-two failed to meet the 2010 target of 5.75% use of biofuels in transport. The heating and cooling sector also experienced only slow growth from 2005 (European Commission 2013a). The Commission predicts, despite this relatively successful beginning, significant difficulties in reaching 2020 targets - primarily due to difficulties in implementing the other provisions of the Directive, including grid administrative procedure and infrastructure requirements, and support scheme disruption.

The Commission reports that progress in removing administrative barriers to renewable energy development is limited and slow, and many Member States did not even address such reforms in their 2011 progress reports. The availability of single administrative bodies for dealing with renewable energy project authorisations is rare – with only Denmark, Italy, Netherlands, Greece and Portugal taking such an approach. Authorisation and planning procedures remained a key challenge to electricity infrastructure development, however the Commission reports that there is clear evidence for most Member States making at least some progress towards reforming their electricity grid infrastructure, and rules for operation and access surrounding them, however this is happening at a relatively slow pace.

As this instrument mandates a method of emissions mitigation (i.e. the growth of low-carbon energy), and does so through differentiated targets for each Member State (which is unlikely to be the cheapest approach, given the target calculation methodology – although statistical transfers improve this aspect to an extent), and with different types of support mechanisms producing different implicit carbon costs and incentives for investment, it cannot be considered statically efficient. With an aim to improving general cost-efficiency, the Commission is taking steps to produce guidance informing Member States of best practice in support mechanisms, to ensure instruments correct market failures rather than produce distortions by, for example, including mechanisms to adjust support in the face of falling capital costs. Whilst there is no real incentive in the Directive for Member States to exceed their targets (only to allow statistical transfers), and therefore dynamic efficiency cannot be considered high, it is likely the existing targets have and will spur innovation and drive technology cost reductions. Although the literature is lacking in evidence for this effect attributable directly to this Directive, the rapid reduction in costs for certain technologies (solar PV, for example), is likely to have been driven significantly by the promotion of renewables under such targets.

The Commission's report also details the sustainability criteria applied to the use of biofuels. It concludes that these criteria are largely implemented across Member States, with some legal proceedings underway to complete full transposition across the EU. In 2010, biofuels made up an average of 4.7% of the EU's transport fuel - below the 5.75% target. The bulk of this consumption came from France, Germany, Italy, Spain and the UK. Over 80% of biofuel consumed in the EU was produced domestically, with Argentina the largest importer at over 10% of total consumption. Estimated GHG savings from the use of biofuels is 25.5MtCO_2e, based on Member State reporting (European Commission, 2013a). However, this estimate does not include the indirect emissions associated with biofuels (e.g. land use change), which would reduce this estimate significantly. To account for this, in 2012 the Commission proposed amendments to both this Directive and the Fuel Quality Directive, which will consider such aspects in emissions accounting. The proposed amendment, which was passed committee stage in July 2013 with some alterations, will also limit the use of food-based biofuels to 5.5% of the 10% transport target, along with a 2% target for the use of advanced biofuels (which

currently accounts for only 1.4% of EU consumption), and 2% for the use of renewable electricity in transport. Parliament is expected to vote on the amendments in Autumn 2013. Regarding wider economic impacts, the Commission estimates that EU biofuel policy contributed an additional 1%-2% to global cereal prices in 2010, and 4% to food oil crop prices. This has obvious impacts on global food affordability. However alongside this, it is estimated that this same policy has created 220,000 jobs within the EU, and 1.4 million globally (European Commission, 2013a).

As evidenced by the slow pace of change discussed above, administrative feasibility may be considered relatively low. At the time of writing, fifteen Member States are at the beginning of the infringement process for failing to fully transpose the provisions of the Directive. Political acceptability is also difficult in many countries, which do not wish to be imposed on to generate a given level of renewables from the EU. This is compounded by the division of opinion over the use of biofuels, and the sustainability issues therein – despite proposed amendments. Unintended consequences are also inevitable or an instrument of such size and scope. The impact on global food prices is one such negative example.

CCS Directive

The CCS Directive (2009/31/EC) establishes a legal framework for the environmentally safe geological storage of CO_2 captured by CCS technology, in such a way to prevent negative impacts to the environmental and human health. The provisions of the Directive apply to the geological storage of CO_2 within a Member State's territory, their exclusive economic zones and continental shelves as defined by the UN Convention on the Law of the Sea (Unclos). It does not apply to sites with intended storage below 100ktCO_2 undertaken for research and testing purposes. Sites with a storage complex extending beyond the geographical scope described are prohibited, along with storage of CO_2 in the water column. Other Directives deal with the capture and transportation of CO_2.

Member States may decide whether to allow the geological storage of CO_2 within their territory. If permitted, the provisions of this Directive must apply. Member States must undertake an assessment of the storage capacity across parts or the whole of its territory, including by exploration. No exploration may take place without a permit, which must be issued in accordance with objective criteria, be limited to a defined area and last no longer than is required to complete the exploration. The suitability of a site for geological storage must be based on a thorough characterisation an assessment of the potential storage complex and surrounding area determined by, *inter alia*, computer models and simulations of CO_2 injection, risk identification and an assessment of the impact on local people, habitats and species. A site shall only be considered suitable for storage if there is no significant risk of leakage, or environmental or health risks.

Once a site is deemed suitable for storage, an operator must obtain a permit before any storage activities take place. If a site is transboundary, Member States must co-operate in its management. Applicants must prove their technical competence and describe measures to be put in place to prevent significant irregularities, along with proposed monitoring plans, potential corrective measures to be applied in the event of problems and any post-closure arrangements (all discussed below). The designated competent authority in a Member State

may only grant a storage permit if it is convinced that all requirements of this Directive and all other relevant legislation are met. However, all applications and intended decisions must be passed to the Commission for review. Member States may ignore the recommendation given by the Commission, but sound reasoning must be provided. All permits must be reviewed five years after issue, and every ten following this. Competent authorities may withdraw a permit and assume management of a site in the event of failure to meet permit conditions (especially CO_2 leakage), and may recover all costs from the previous operator.

Member States must ensure that site operators monitor injection facilities, storage complex and CO_2 plume, and where appropriate, the surrounding environment, in line with their storage permit. Monitoring systems should detect any irregularities against expected behaviour (including pressure, temperature and seismic activity), and migration and leakage of CO_2, especially where this may have a particular effect on drinking water, human populations and the surrounding environment. The composition of the CO_2 stream should also be monitored to ensure no waste, other materials or gasses are entering the storage site. Operators should report the results of their monitoring activities to competent authorities annually, and should update monitoring plans every five years to take into account advances in technology and scientific knowledge. Competent authorities are required to put in place a system of routine and non-routine inspections of storage complexes. Routine inspections should take place at least annually until three years after closure of the site, then every five years until the site has passed into control of the competent authority. Non-routine inspections should be carried out if serious complaints have been received, if reports of leakages or potential risk to human or environmental health have been received, or if it is believed any other conditions of the storage permit are being breached.

In the event of leakages or other serious irregularities, corrective action must be taken immediately in line with the corrective measures plan. The competent authority may oblige the operator to take additional measures, or may implement measures itself. Any costs of this may be recovered from the site operator. In the case of leaks specifically, the operator must notify the national competent authority responsible for the EU-ETS, and is required to surrender allowances consummate with the leakage volume. Liability for other environmental damage (e.g. water pollution or damage to surrounding habitats) is covered under the Environmental Liability Directive (2004/35/EC).

Once a storage site has been closed the operator is responsible for sealing the site and removing injection equipment, and remains responsible for monitoring, reporting and corrective measures required, until responsibility is fully transferred to the competent authority (at least 20 years after closure), in line with the post-closure plan presented as a condition of the storage permit. The operator must provide a financial contribution to the operator to cover the costs of managing the site for a period of 30 years, post-closure. Member States must maintain a register of all storage permits issued, and all closed sites.

The Directive provides no prescriptive penalties that must be levied in cases of breaches of its provisions. Instead, Member States must implement effective, proportionate and dissuasive penalties of their own design. Member States must report to the Commission on the implementation of this Directive every three years (with the first report submitted by 30th June 2011). This report is based on a standardised questionnaire, developed by the Commission.

Within nine months of this deadline the Commission must report to the European Parliament on overall implementation. The second report, to be submitted by 31st March 2015, should assess several aspects of the Directive in light of experience and technological advances. This includes whether the environmental and human safety of geological storage of CO_2 has been demonstrated, the need for further regulation, and the prospects for geological storage of CO_2 in third countries. A proposed revision of the Directive should then be presented, if required. DG CLIMA is the centralised authority responsible for this instrument, with environment departments largely responsible at Member State levels – although with heavy representation from departments of economy and industry (e.g. Netherlands, Italy, Spain).

As this instrument provides a legal framework to ensure safe geological storage of CO_2 rather than encouraging emissions abatement, it cannot be assessed for optimality along the same lines as other instruments discussed in this paper. It may indirectly encourage the development of CCS technologies (especially storage) through regulatory certainty, however other instruments are likely to influence this to a much greater degree. Administrative feasibility is an apparent issue with this Directive, as twenty-five Member States failed to transpose its provisions by the deadline of 25th June 2011 (European Commission, 2012b).

1.2.4 Non-Carbon Dioxide Greenhouse Gas Emissions

Some instruments that fall under this policy landscape (as illustrated in Table 1**)** also fall under other policy landscapes. In this instance, they are discussed under what may be considered their 'primary' landscape. Such instruments that fall under this landscape but are discussed elsewhere are the EU-ETS and Effort Sharing Decision.

F-Gas Regulations

Fluorinated gases (F-gases) are man-made GHGs used primarily in industrial applications, with a global warming potential (GWP) of up to 23,000 times that of CO_2. There are three classes of F-gases, namely hydrofluorocarbons (HFCs) (the most common, used in refrigeration, aerosols and air-conditioning), perfluorocarbons (PFCs) (used in the electronic, cosmetic and pharmaceutical industries), and sulphur hexafluoride (SF_6) (used as an insulating gas and in the production of magnesium and aluminium). These gases account for around 2% of the EU's GHG emissions, and their use has risen by nearly 60% since 1990. The Commission passed two items of legislation in 2006 in order to combat these emissions. The first is the 'MAC Directive' (2006/40/EC), which tackles the use of F-gases in air conditioning units in vehicles (Mobile Air Conditioning), whilst the 'F-Gas Regulation' (842/2006), deals with their use in other key applications. Specifically, the objective of the F-Gas Regulation is to contain, prevent and reduce emissions of f-gases listed in Annex A of the Kyoto Protocol.

The Regulation achieves this through two 'tracks of action'; the first of which aims at improving the prevention of leaks from equipment containing F-gases. Operators of refrigeration, air conditioning, heat pumps and fire protection systems must ensure certified personnel check this equipment for leakage. Equipment containing more than 3kg, 30kg and 300kg of F-gases must be checked at least every twelve months, six months and three months respectively. Any

leakages must be repaired as soon as possible after discovery. In addition, operators of equipment containing more than 3kg of F-gases must maintain records on the quantity and type of F-gases installed, added or removed from the equipment, whilst equipment containing over 300kg must have a leakage detection system installed. Upon disposal of refrigeration cooling circuits, air-conditioning and heat pump equipment, F-gas based solvents, fire protection equipment and high-voltage switchgear, arrangements must be made for certified personnel to recover F-gases from this equipment, to ensure their recycling, reclamation or destruction. These items of equipment, along with all F-gas containers, must also be appropriately labelled with the volume, type and GWP of the F-gases contained within. Certified personnel (involved in both equipment checking, maintenance and disposal), must adhere to Member State level certification criteria. The Commission approves these schemes, and Member States must recognise certification awarded in by each other.

Each producer, importer and exporter of F-gases (in excess of one tonne) must report annually to both the Commission and their Member state on their total volume of production, import or export, broken down by f-gas and, for producers and importers, final use of these gases. The volume of f-gases placed on the market by producers and importers must also be reported, along with any volumes reclaimed, recycled or destroyed. Exporters must also report on this final aspect for all exported volumes.

The second 'track of action' is to avoid the use of f-gases in applications where cost-effective, environmentally superior alternatives are available. To this end, the use of sulphur hexafluoride in magnesium die-casting (above 850kg/year) was banned in 2008. The use of f-gases is also banned in non-refillable containers, windows, footwear, tyres and foams. Hydrofluorocarbons and perfluorocarbons are banned in non-confined direct-evaporation systems containing refrigerants, fire protection systems and extinguishers and novelty aerosols.

Member States must determine individual penalties to enforce the provisions of the regulations, in an effective, proportionate and dissuasive manner. In 2011, the Commission published a review of the Regulation, which suggested that significant additional emission reductions could be achieved if the Regulation was strengthened, and its existing provisions fully applied. Following this, in November 2012, the Commission published a proposal for a revision of the Regulation, containing the following provisions:

- An HFC phase-down, with a gradually declining cap from 2016 (with a freeze in 2015), leading to a 79% reduction in HFCs by 2030 from 2008-2011 levels. This would be achieved through a cap-and-trade mechanism, with free allocation based on previous reporting. Around 100 companies would be expected to participate.
- To compliment this cap, certain market restrictions are also proposed. A ban on certain products with HFCs with a GWP of over 150 is proposed, beginning with domestic refrigerators and freezers in 2015, followed by commercial refrigerators and freezers and movable room air-conditioning appliances by 2020. A ban on commercial refrigerators and freezers containing HFCs with a GWP over 2,500 is proposed with effect from 2017.
- In addition, a ban on recharging existing refrigeration equipment with a charge size over 5tCO_2e with HFCs of very high GWP (>2,500) should be banned from 2020.

- Additional reporting obligations are proposed to cover f-gases not currently covered by the Regulations.

In June 2013, the proposal was slightly amended to tighten the originally proposed phase-down target from 79% to 84% below 2008-2011 levels, by 2030. An allocation fee of €10/tCO_2e is also proposed for producers and importers when accessing their quota under the proposed cap is also suggested, with the revenue used to finance projects to accelerate the uptake of alternative technologies. A proposal for a ban on exporting appliances using f-gases has also been inserted, to prevent appliances being 'dumped' outside of the EU. Further discussions are expected to resume towards the end of 2013. DG CLIMA holds responsibility for this instrument, with varied departments holding responsibilities at the national level.

According to the 2011 review of the Regulation, by the end of 2010 individual aspects of the Regulation had met with varied levels of implementation success (European Commission, 2011d). The implementation of f-gas use and marketing restrictions has been almost fully successful. Provisions on product labelling and reporting have also experienced successful implementation. However, a low level of compliance was reported for containment measures, especially in Member States where no similar requirement was previously active. The required schedule for leakage checks was found to be particularly low amongst small commercial operators of stationary refrigeration, air conditioning and heat pumps, with record keeping below 50%. In large applications where the installation of leakage detection systems is required, compliance was reported as high only where such requirements were already present. F-gas recovery was low prior to the introduction of the Regulation, and whilst data indicated a slight increase in recovery, systemic data to make a full assessment was lacking. However, it is expected that volumes recovered will increase dramatically in the coming years as existing equipment reaches end-of-life. At the time of this assessment data was only available to assess the CO_2e savings from the f-gas use and marketing restrictions. Analysis estimated that 3 million tCO_2e had been saved by the end of 2010 from these provisions, compared to the counterfactual. Limited literature exists examining the change in levels of compliance and estimated CO_2e emission savings since this review was produced.

This instrument is statically inefficient, as it limited in GHG and equipment scope. It is also applies different provisions to different products – f-gasses are banned in some products, but not in others. The most cost-effective reduction of overall use of f-gases is then not necessarily achieved (however, the products subject to a ban are able to make use of cost-effective alternatives). The imposition of the proposed cap-and-trade mechanism to achieve further reductions, however, would improve overall static efficiency. This introduction would provide on-going incentive to reduce f-gas use and thus increase the low dynamic efficiency delivered by a command-and-control instrument such as this. However, innovation in alterative substances for traditional f-gas applications – such as foam products developed for use in refrigeration appliances, is occurring (European Commission, 2011d). Additionally, whilst there is currently no incentive to move beyond the minimum requirements set by the Regulation, many Member States have done so – largely to help in achieving broader domestic emission reduction targets. The 2011 review estimated the implicit carbon cost at the end of 2010 to be around €41/tCO_2e reduced. It may be concluded, based on the varied success in implementation of different provisions, that administrative feasibility of the Regulation is relatively low, especially in Member States with no previous experience in similar regulation.

Landfill Directive

The objective of the Landfill Directive (1999/31/EC), is 'to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill' (Article 1), through the use of technical and operational requirements. The requirements of the Directive apply to any landfill within the EU, but do not apply to the spreading of sludges, the use of 'inert' waste (defined below) in redevelopment, filling-in work or for construction purposes, the deposit of non-hazardous dredging sludges along small waterways from where they have been dredged, or the deposit of unpolluted soil or inert waste resulting from prospecting and extraction, treatment and storage of mineral resources as well as from the operation of quarries.

Each landfill must be classified as accepting 'hazardous waste', non-hazardous waste' or 'inert waste', and accept only waste matching that description. 'Hazardous' waste is generally that defined by the Hazardous Waste Directive (91/689/EEC). 'Inert' waste is that which does not undergo any significant physical, chemical or biological transformation, or adversely affect other matter in which it comes into contact in such a way that may give rise to environmental pollution or harm human health. 'Non-hazardous' waste is that which falls outside of these two categories (e.g. municipal waste). Waste of any type must be subject to treatment before landfilling (a process to reduce the volume or hazardous nature of the waste, or to facilitate handling or enhance recovery), although inert waste is exempt from this requirement if treatment is technically infeasible, or the effect of treatment is minimal. The Directive also prohibits the landfilling of liquid waste, waste which is explosive, corrosive, oxidising or flammable, clinical waste and whole tyres.

Any new landfill must apply for a permit from a designated competent body within the relevant Member State, and must contain at least the minimum prescribed information as listed in Article 7 of the Directive, including the intended classification of the landfill, proposed methods for pollution prevention and abatement, operation, monitoring and control plans, and proposed closure and aftercare procedures. Various other aspects concerning the specific location of the landfill, such as local geology and hydrology, are also considered. In order to issue a permit, the competent body must be satisfied that all aspects of the Directive are satisfied.

Landfills in existence at the time of transposition of this Directive (for which the deadline was 16th July 2001), were required to present (within one year of the transposition deadline), a 'conditioning plan' for approval by competent authorities, outlining plans for meeting the same requirements as new landfills applying for permits. The Member State must have assessed this plan and decided whether to close the landfill, or to enter a transitional phase under which the plan must be implemented. All existing landfills must have been in compliance within eight years of the transposition deadline (i.e. 16th July 2009).

During operation of the landfill, operators must follow 'reception procedures' to ensure only waste that meets the category of the landfill is accepted, which includes visual inspection (at least) of the waste at point of deposit to verify it matches with the type of waste described in the accompanying documentation. The landfill operator must provide a written receipt for each

delivery of waste accepted on the site, and must keep a register of the quantities, characteristics and origin of all waste accepted. A monitoring programme must also be implemented for the operational life of the landfill, which must meet the requirements laid out in Annex III of the Directive, including the monitoring of groundwater and surface water flows, and the production of leachate and landfill gas. Landfill operators must report at least annually to a competent authority on the types and quantities of the waste disposed, and the results of the monitoring programme. Upon closure of the landfill, either due to conditions in the permit or under authorisation of the competent authority, the competent authority must inspect the site and oblige the operator to continue maintenance, monitoring and control of the site for as long as is deemed necessary to prevent and reduce environmental harm. The Directive also stipulates that the full lifecycle direct cost of establishing, operation and monitoring, closure and aftercare of the site (for at least 30 years), must be recovered through the cost charged by the operator for the disposal of waste to the site.

In addition to these specific operational and technical requirements implemented at the site level, each Member State was required to devise a national strategy for the reduction of biodegradable waste going to landfill (a prominent source of landfill gas – methane), by 16th July 2003). The strategy must deliver a 75% limit on biodegradable municipal waste entering landfill by 16th July 2006, from the volume placed into landfill in 1995 (by weight), in each Member State. This reduced to 50% in July 2009, and will reduce further to 35% in July 2016. However, the 2016 target may be reviewed in 2014 based on experience acquired thus far. Strategy must achieve these targets through recycling, composting, biogas production or material and energy recovery (or a combination of approaches). At three-year intervals from transposition of the Directive, Member States must report to the Commission on the implementation of the Directive – paying particular attention to the progress of national strategies. The Directive does not outline any penalties for failing to meet the provisions therein, either at landfill operator or Member State level. Infringement proceedings must then be brought under existing legal frameworks. DG Environment holds central oversight, with national environment departments generally responsible for implementation of key provisions in the Directive. Other departments are involved depending on national-level instruments, such as taxation authorities when a landfill or collection tax is employed (e.g. HMRC in the UK).

Despite some specific, minor deficiencies, a European Commission (2009b) report concludes that transposition and implementation of the provisions of the Directive had been successful across the EU. A separate European Commission (2009a) report concluded that the Directive has been clearly effective in achieving its objectives. The number of landfills in existence has decreased markedly across the EU, due in large part to the closure of poor quality sites unable to meet the requirements of the Directive (although this trend began before the introduction of the Directive in some Member States). Whilst the Directive has failed to reduce the volume of waste generated, especially biodegradable municipal waste, the volume landfilled has decreased drastically. Whilst five Member States failed to meet their biodegradable waste target in 2006, France, Italy and Finland had reached already reached the 2009 target and six other States had already reached the 2016 target. The Commission concludes that this success is due to two core issues – the use of short and medium-term targets to achieve long-term goals, and the flexibility afforded in the Directive for the use of nationally appropriate instruments to achieve these targets. A range of regulatory, economic and voluntary measures are employed in different Member States to achieve the goals of the Directive. This includes

landfill tax (widely used), charges for waste collection (the price for landfilling waste must reflect the lifecycle cost), landfilling bans and separate collection of biodegradable waste.

As the Directive attempts to reduce methane emissions only, and despite the flexibility, attempts to achieve so through relatively prescriptive measures (prevention of biodegradable material landfilling – it does not prevent emissions from other end uses of biodegradable waste), it is relatively statically inefficient. However, it does have broad impact across the economy, and attempts to correct a market failure by mandating that the full cost of landfilling be reflected in the price. It is therefore relatively dynamically efficient, as there is a continued incentive to reduce waste to landfill (to the level by which alternatives cease to be cost-effective), despite the lack of direct link to consequent methane emissions.

Nitrates Directive

The Nitrates Directive (91/676/EEC) aims at protecting water quality by preventing surface and groundwater pollution caused or induced by nitrates from agricultural sources through the promotion of good farming practices, and forms a key part of the Water Framework Directive (2000/60/EC). The nitrogen present in livestock manure and artificial fertilisers oxidises in the soil when applied, producing nitrous oxide (N_2O), a GHG with a GWP of around 300 that of CO_2. Anthropogenic N_2O emissions in the EU are equal to around 10% CO_2 emissions (in CO_2e terms).

Member States must identify polluted waters, or water at risk of pollution such as surface freshwaters (in particular those used or intended for the abstraction of drinking water, and groundwater containing or that could contain a concentration of 50mg/l of nitrates), and freshwater bodies, estuaries, coastal and marine waters found to be eutrophic or that may become eutrophic (unless action is taken to reduce this risk). Member States must then designate any areas of land that drain into the water bodies identified above, and which contribute to pollution, as ‘Nitrate Vulnerable Zones’ (NVZs). This requirement is waived if an action programme (discussed below) is applied to the whole of a Member State’s territory. Article 4 of the Directive obligates each Member State to develop a code of good agricultural practice, with the aim of providing a general level of protection from nitrate pollution to all waters, to be adopted by farmers on a voluntary basis. Codes should include:

- Measures limiting the periods when nitrogen fertilisers can be applied on land in order to supply nitrogen when required by crops, and to prevent excess fertiliser entering water bodies.
- Measures limiting the conditions for fertiliser application, for example not on steeply sloping ground, frozen or snow-covered ground or near watercourses, to prevent nitrate losses from leaching and run-off.
- Requirement for a minimum storage capacity for livestock manure
- Crop rotations, soil winter cover and catch crops to prevent leaching and run-off during wet seasons.

For famers within areas designated as an ‘NVZ’, an ‘action programme’ must be implemented on a mandatory basis, which includes the codes of practice discussed above, alongside other

measures such as the limitation of fertiliser application (mineral and organic) taking into account crop requirements, all nitrogen inputs and soil nitrogen supply, and a limit on the amount of livestock manure to be applied (170kg nitrogen/hectare/year). This action plan may be implemented across the entire Member State's territory, at the Member State's discretion. These are also minimum requirements; if it becomes clear that these prescriptive measures are insufficient to achieve the objectives of the Directive, Member States may take additional, cost-effective measures.

Member States must draw up monitoring plans to assess the effectiveness of this action programme, and review (and if necessary, revise), every four years. Member States must also monitor nitrate concentrations in surface and groundwater (through samples taken at least monthly), and review the eutrophic state of their fresh surface, estuarial and coastal waters. The results of this monitoring and review must be reported to the Commission at least every four years (beginning in 1995). DG Environment holds EU-level responsibility for this Directive, with national departments responsible for the environment and agriculture (often the same department), usually nominated as competent authorities.

In 2010, the Commission reported that 40.9% of the EU-27 area had been designated as NVZs, including 'whole territory' approaches by Austria, Denmark, Finland, Germany, Ireland, Lithuania, Luxembourg, Malta, the Netherlands and Slovenia (European Commission, 2011b). Despite an overall 6% increase in the use of nitrates across the EU-27, in 70% of the extensive surface water monitoring station network, there are stable or decreasing nitrogen concentrations - and 66% for groundwater stations. There currently exist around 300 action programmes, of which quality is continually improving. Efficient management of nutrients and increasing uptake of manure processing technology has been observed in livestock intensive regions. Velthof *et al* (2010) estimate that by 2000, the Directive had produced 3.1% N_2O emission savings compared to the counterfactual, and 6.3% by 2008. They conclude this is at the higher end of potential savings. The Commission estimates that with full implementation of the Directive's provisions, a further 6% could be saved by 2020, from 2010 levels. Implementation of the Directive remained incomplete in 2010, with three open infringement cases against Spain, France and Luxembourg, surrounding insufficient designation of NVZs and non-conformity of action programmes. In addition 2008/09 was the first period in which all Member States made a formal submission regarding the status of the Directive within their territory. This Directive may be considered both statically and dynamically inefficient. It encourages very specific emissions reductions from a narrow source, and mandates how this should be done in NVZs. Outside of these regions, its relies on a voluntary approach. The cost of reduction will vary across time, space and land use activity; imposing unequal costs across the EU and within Member States – although there is little evidence in the literature upon which to assess this conclusion. However, Member States do have the flexibility to impose nationally appropriate measures to achieve their goals, including those that go beyond the stated minimum requirements. Whilst this may improve environmental effectiveness, it may also place additional burden on obligated parties. Also, there is generally little incentive for farmers and other land users to continually seek improvements beyond that required of them in imposed action plans.

LULUCF Accounting Rules

Forests, wetland, peat land and agricultural land covers around three-quarters of the EU's territory, and naturally hold a significant stock of carbon in soils and other biomass. These landscapes absorb an equivalent of 9% of annual GHG emissions emitted across the EU (European Commission, 2012a). As such, 'Land Use, Land Use Change and Forestry' (LULUCF) has a significant impact on net emissions in the EU. LULUCF sector emissions are reported to the UNFCCC, and are partially accounted under the Kyoto Protocol, however there has been an historic lack of common measurement and accounting rules for consistent reporting of emissions (either positive or negative). In December 2011 at COP17 in Durban, a set of revised rules for LULUCF accounting and reporting was adopted for use under the Framework Convention. Despite the importance of LULUCF, the historic lack of a consistent approach meant the sector was not considered in the headline targets or sub-measures in the EU's Climate and Energy Package. In March 2012, in light of the revised accounting rules at the international level, and as required by Decision 406/2009/EC (Effort Sharing Decision), the Commission announced a proposal to establish robust common accounting, monitoring and reporting rules for LULUCF in the EU, in the form of a dedicated legal framework, in line with the international agreement. Following agreement by the Council and European Parliament, the Decision (529/2013/EU) entered into force on 8th July 2013 This is proposed as a precursor to including LULUCF in overall EU GHG reduction efforts and associated targets.

Between 1st January 2013 and 31st December 2020 (the first accounting period), Member States must maintain accounts for all CO_2, methane (CH_4) and N_2O emissions and removals resulting from afforestation, reforestation (on lands not forested on 1st January 1990), deforestation, forest management, cropland management and grazing land management activities within their territory. Accounting for revegetation, wetland drainage and rewetting is voluntary. Specifically regarding CO_2, accounts must include changes in the carbon stock of the key carbon pools of above and below ground biomass, litter, dead wood, soil organic carbon and harvested wood products. On the basis of transparent and verifiable data, the land upon which the above activities take place must be precisely identified. Emissions arising from natural disturbances (i.e. forest fires) do not have to be accounted.

Articles 5 to 9 of the Decision outline specific accounting methodologies for different types of LULUCF activity. Net changes in CO_2 for afforestation, reforestation and deforestation should be calculated on an annul basis, by taking the carbon stock present on 31st December each year, minus the carbon stock present on 1st January of that same year. For CH_4 and N_2O, emissions occurring each year in the accounting period should be reflected. For forest management activities accounts must be calculated as total emissions and removals between 1st January 2013 and 31st December 2020, minus the value obtained by multiplying the number of years in that accounting period (eight), by the reference level net emissions from forest management activities specified for each Member State in Annex II of the Decision.

Member States must also reflect emissions from harvested wood products (paper, wood panels and sawn wood), sourced from within the Member State's territory, as of 1st January 2013 (even when the products in question were harvested before this date). Emissions from such products are calculated in accordance with a first order decay function and standard half-life values (found in Annex III of the Decision).

By 8th January 2014 (and within six months of the beginning of any subsequent accounting period), Member States must draw up and submit to the Commission a LULUCF 'Action Plan' to limit or reduce emissions and maintain or increase GHG removal resulting from the activities discussed above. The Plan must cover the entire accounting period to which in relates, and must have been designed in consultation with a broad range of stakeholders. It must include the following aspects for each LULUCF activity discussed:

- Description of historic trends of emissions and GHG removals
- Projections for emissions and removals for the accounting period in question
- An analysis of the potential to limit or reduce emissions and removals for the respective accounting period
- A list of measures to be adopted in order to achieve emission mitigation potential, such as extending crop rotations and avoiding the use of bare fallow, improving nutrient management, improving grazing land management through management of the intensity and timing of grazing and prevention of conversion to cropland, and preventing deforestation.
- Policies foreseen to implement the measures described above, including a description of the expected effect of these measures on emissions and removals
- A timetable for adoption and implementation of these measures and policies

The Commission will review each Action Plan, and may provide recommendations for improvement. Each Member State must also submit a report on the progress of the implementation of their Action Plan, both in the middle of an accounting period (e.g. 2017), and the end of the period (e.g. 2020). The Commission shall review these rules within a year of the end of the first accounting period (2021). The Decision indicates no specific penalties for non-compliance with these requirements. DG CLIMA hold responsibility for these rules at EU-level, with national environment departments (as those generally responsible for emissions inventories), usually hold national-level competence.

As the Decision is extremely recent and Member State obligation timeframes have not yet been reached, the instrument's optimality can only be briefly assessed ex-ante. As the rules are based on an international standard, adopting the elements of the Decision in EU Member States should be highly feasible (however, there are no specific penalties for non-compliance). Effective accounting of LULUCF emissions should then achievable. The long-term goal of including LULUCF in the broader EU emissions targets should then be relatively straight forward, as a basis to reducing net emissions in the sector.

Although the decision at present cannot be considered statically or dynamically efficient, as it focuses on a single sector and does not actually provide and incentive to reduce these emissions, it does lay the foundation for improving the scope of emission reduction opportunities in the EU in future. It is also likely to render little cost to any party (largely government), at this stage.

1.3 Identification of interactions of instruments within each policy landscape

1.3.1 Carbon Pricing

Objectives

The explicit objective of the EU-ETS is the reduction of GHG emissions (primarily CO_2). The primary objective of the ETD is to improve the functioning of the internal market, with secondary objectives of ensuring greater respect for the environment (although not explicitly through the reduction of GHG emissions), and to encourage employment through switching taxation from labour to energy products. As such, the objectives of the instruments do not directly align at present. The proposed revision of the ETD would raise the reduction of CO_2 emissions to a primary objective of this instrument, bringing it more in line with the objectives of the EU-ETS.

Scope and Coverage

The EU-ETS is directly linked to CO_2 emissions (with limited coverage of N_2O and perfluorocarbons from certain sectors), whereas the ETD is at present linked only indirectly to CO_2. Both instruments have wide sectoral coverage. The EU-ETS applies to the large-scale production of electricity and heat, and a range of other energy-intensive industry. The ETD applies economy-wide to the consumption of electricity and motor fuels, and energy products used in the generation of heat (with exemptions). Products used for the production of electricity are exempt, alongside possible exemptions for heating in energy-intensive industry and domestic use, and all energy products used in the agriculture and international aviation sectors. There is relatively little direct target group overlap between the two instruments. Although energy-intensive industry is subject to both instruments, the ETD concerns electricity consumption, whilst the EU-ETS concerns process emissions. As such, there is no direct regulatory overlap.

Functioning and Influencing Mechanisms

At present, the EU-ETS and ETD have a conflicted relationship. Whilst the EU-ETS directly incentivises emissions mitigation, the ETD favours the use of carbon-intensive fuel (especially coal). Whilst this does not cause direct conflict in the production of electricity, for example, it causes conflict economy-wide, as a reduction in the use of coal for electricity production may be counteracted by its incentivised use for heating in other sectors. The EU-ETS, by discriminating against CO_2, encourages the development and use of low-carbon electricity. However, the ETD does not discriminate between high and low carbon generation. Whilst this does not directly counteract the objectives of the ETS, it does not actively support it. The overlapping scope of the instruments, discussed above, also places double carbon costs on electricity end users and other selected sectors.

The proposed revision of the ETS would turn the interaction of these instruments into a highly supportive relationship, with incentives aligned against CO_2 emissions. With the carbon component of the ETD aligned with the EU-ETS price, the incentive for reduction is theoretically equalised across the scope of the two instruments, with little direct overlap.

Implementation Network/Administrative Infrastructure

Responsibility for the EU-ETS at EU level rests with DG CLIMA, and with DG Taxation and Customs for the ETD. Whilst much of the operation and design of the instruments are at the EU level (especially the EU-ETS from Phase 3 onwards – including operation of a centralised trading platform used by the majority of Member States), implementation for both instruments, as with all instruments discussed in this paper, are at the national level via competent authorities. Departments responsible for the environment generally manage the EU-ETS, whilst finance authorities manage the ETD. There appears to be little overlap or interaction in administration between the two instruments.

1.3.2 Energy Efficiency and Energy Consumption

Objectives

Five of the nine instruments in this landscape hold emission mitigation as an explicit primary objective to be achieved either in part of in whole through the promotion of energy efficiency. These are the EU-ETS, the ESD, EPBD, CO_2 emission standards for passenger vehicles, and CO_2 labelling of passenger vehicles. Two of the nine (the EED and Energy Labelling Directive), hold energy efficiency as the end goal, but with a desired impact of emission mitigation. The remaining two – the ETD and Ecodesign Directive – aim to ensure the effective functioning of the internal market as their primary objective, with energy efficiency as a secondary objective. Two of the instruments – the ESD and Ecodesign Directive – state the advancement of energy security as secondary objectives.

Scope and Coverage

Four of the nine instruments in this landscape hold a large sectoral scope. This includes the EU-ETS and ETD, the scopes of which have been discussed. The ESD's scope is the remainder of the economy not obligated under the EU-ETS (such as buildings, non-aviation transport, agriculture and waste), aside from LULUCF and international shipping. The entire economy in each Member State is within the scope of the Energy Efficiency Directive at a broad level – generators, suppliers and consumers of energy, but with some provisions therein having specific scope. The remaining five instruments have a much more specific scope. The EPBD covers buildings - public and private, new and existing. The Ecodesign and Energy Labelling Directives cover energy-related products, with their implementing regulations impacting specific products. The regulations surrounding emission standards and labelling of passenger cars are self-explanatory in their scope.

The ESD is the only instrument discussed in this paper to explicitly concern all six GHGs highlighted in the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride), in the sectors it concerns. The EU-ETS concerns primarily CO_2, but also N_2O and perfluorocarbons to a limited extent, whilst the instruments for CO_2 emission standards and labelling for passenger cars impose a direct link to CO_2 only. The remaining five instruments – the ETD, Energy EED, EPBD, Ecodesign Directive and Energy Labelling Directive, concern the use of energy and energy efficiency directly, with a CO_2 emission mitigation a desired policy impact, but an indirect one.

Functioning and Influencing Mechanisms

Three of the four broad instruments in this landscape – EU-ETS, ESD and EED, have a generally mutually supportive relationship. The EU-ETS and ESD compliment each other by capping emissions from different sectors of the economy, to obligate almost all sectors to produce emissions savings. Article 10 of the ESD states that the scope and emission cap under the ESD may change in response to such alterations in the EU-ETS, flexibly maintaining this coverage without a double obligation. Other instruments may then be used to maintain the caps set by these instruments (especially the ESD). An inconsistency arises in the potential use of CDM credits from HFC23 and N_2O projects in compliance with the ESD, which contradicts the ban on such credits under compliance with the EU-ETS. However, as most Member States have voluntarily ruled out the use of these credits under the ESD, this is unlikely to produce problems. The EED promotes energy efficiency for energy generators, suppliers and end users, contributing to the goals of both the EU-ETS and ESD. As discussed under the 'Carbon Pricing' landscape, the ETD experiences a conflicted relationship with the EU-ETS, but also with the ESD and EED, for the same reasons. However, if the proposed amendments to the ETD were enacted, this would become a highly supportive relationship, with the Commission estimating the ETD alone could be responsible for meeting 37% of the ESD emission abatement targets.

The EED experiences a mutually supportive relationship with the Ecodesign Directive, Energy Labelling Directive and the EPBD, as it requires central governments to purchase services, products and buildings with high energy-efficiency performance (with local government 'encouraged' to do so). The Energy Labelling Directive also mandates that public bodies must purchase products that meet the highest energy-efficiency classification (if cost-effective). The largest interaction with the EED is found with the EPBD. The EED mandates that 3% of the building stock owned and occupied by central government is renovated annually to meet EPBD requirements (excluding those which already meet these standards), supporting the leading role of the public sector encouraged by the EPBD its nearly-zero energy buildings requirements. The Commission estimates that EED renovation target and the purchase of new buildings, products and services of high energy-efficiency requirement in the public sector will generate energy savings of 9-18Mtoe in 2020 (European Commission, 2011b). The EED also requires the installation of smart meters (for electricity and gas), when an existing meter is replaced, a building undergoes major renovation (as defined by the EPBD), or a new connection is made. This strengthens the EPBDs efforts to 'encourage' the installation of such equipment.

The EPBD, Ecodesign and Energy Labelling Directives are also mutually supporting – in particular the latter two instruments, which are highly co-ordinated. Both work to increase the market share of energy-efficient products, and ensure the effective functioning of the internal market. The Ecodesign Directive seeks to 'push' towards higher efficiency using minimum standards, eliminating the least efficient products from the market, whilst the Energy Labelling Directive attempts to 'pull' the market to higher efficiency through awareness raising and information provision, encouraging purchases of units at the highest end of the energy efficiency spectrum. Applicability of minimum standards and labelling is often assessed for products in tandem and in consideration of each other, to produce the most effective combination. However, in some instances labels may indicate the availability of products in a

low energy efficiency classification (e.g. 'G'), that have been removed from the market by the Ecodesign Directive – making such classifications redundant and potentially misleading consumers into believing they are buying a more efficient product relative to availability than they actually are (Waide & Watson, 2013). The EPBD also acts to 'push' the market for many products regulated under the Ecodesign and Energy Labelling Directive towards higher efficiency, such as air conditioners and boilers, by setting minimum efficiency standards for such products used in new and renovated buildings, and also by the requirement for large capacity heating and air conditioning units to be regularly inspected – ensuring that the equipment is functioning effectively and achieving its potential, and that the system itself is suitable for the building it occupies.

The EPBD Energy Performance and Display Energy Certificates share a similar design to Energy Labelling Directive product labels, producing further mutual support. This is extended to the CO_2 labelling of passenger cars requirement, which also shares a similar design in a number of Member States (and is proposed to be a common design across the EU). Aside from this, the CO_2 emission standards and labelling requirements for passenger cars generally experience a neutral relationship with the other instruments within this policy landscape, but share a mutually supporting relationship with each other, in a similar manner to the Ecodesign and Energy Labelling Directives.

Despite the generally supportive relationships between the instruments in this policy landscape the success of most of these instruments in reducing electricity demand in particular may run counter to the long-term objectives of the EU-ETS in producing a decarbonised supply, as reducing overall demand for EUAs dampens the need to reduce CO_2 intensity of the remaining generation.

Implementation Network/Administrative Infrastructure

The most prominent Commission Directorate-General involved in the administration of the instruments in this landscape is DG CLIMA, with the EU-ETS, ESD, and CO_2 emission standards and labelling for passenger cars. DG Energy (EED and EPBD) and DG Enterprise and Industry (Ecodesign and Energy Labelling Directives), are also prominent. National competent authorities are rather diffuse in this landscape, owing to the broad nature of the instruments and their application. Energy and environment departments are expectantly the most prominent, often with direct responsibility for the many of these instruments. Economic and business departments are also present, especially regarding the Ecodesign and Energy labelling Directives, and CO_2 labelling of cars. Transport departments are often involved with this final instrument, as are local governments. As such, the interaction between these instruments varies significantly in each Member State.

1.3.3 Promotion of Renewable Energy

Objectives

Five of the seven instruments in this policy landscape are considered primarily under the EE&EC landscape, and as such their objectives have been discussed. The five instruments under that landscape that hold emission mitigation as a stated primary objective (EU-ETS,

ESD, EPBD, CO_2 emission standards for passenger vehicles, and CO_2 labelling of passenger vehicles), all aim to promote the use of renewable energies alongside promoting efficiency to achieve their objectives.

The Renewable Energy Directive – the key instrument in this policy landscape - holds as its primary objective that of the second pillar of the '20-20-20' targets – raising the share of EU final energy consumption produced from renewable resources to 20%. The CCS Directive simply has the objective of establishing a legal framework for the safe geological storage of captured CO_2.

Scope and Coverage

Again, the scope and coverage of five of the seven instruments in this landscape were discussed under the corresponding EE&EC landscape, and are not repeated here.

The RED places an obligation across the whole economy through its national renewable energy targets, but with specific attention to the electricity supply and transport sectors. The CCS Directive has a very specific scope, and applies only to operators of sites used for the geological storage of CO_2.

Functioning and Influencing Mechanisms

As with the EE&EC landscape, the EU-ETS and ESD have a mutually supportive relationship in encouraging the development of renewables by together capping emissions across the whole economy (with the exception of LULUCF and international shipping). They share a generally supportive relationship with the RED, which encourages the development of renewables across the scope of both of these instruments. Whilst both the EU-ETS and RED encourage centralised renewable electricity generation, the RED also encourages decentralised generation. However, the promotion of renewables through the RED arguably does not produce additional emissions abatement than is delivered through the EU-ETS and ESD instruments alone. If emissions are abated in the electricity sector through an increase in renewables, the EU-ETS allowance price decreases and reduces the incentive for abatement in other (traded) sectors. This is also true under the ESD with the transport sector target imposed the RED (10% renewable energy in transport in all Member States, by 2020), and the resulting decrease in demand for abatement in other ESD sectors, for example.

The regulation for CO_2 emission standards for passenger cars aims to promote the use of biofuels in transport through preferential treatment of vehicles able to operate with E85 fuel in Member States in which at least 30% of filling stations provide such fuel, and when it is in compliance with the sustainability criteria set out in the RED. The relationship between these two instruments is therefore mutually supportive. This is also true for the RED and the CO_2 labelling of cars regulation, which also attempts to encourage the purchase of such vehicles. However, an arguably larger incentive exists for the production of electric and hybrid-electric vehicles under the CO_2 emission standards (super credits), which may increase the demand for electricity from the grid, regardless of its carbon intensity.

The RED experiences a strong mutually supportive link with the EPBD. The EPBD requires that the cost-effective use of renewables must be assessed for all new buildings, and is encouraged for use in renovations. The RED also requires that efforts should be made to consider the use of renewables when planning and building residential and industrial buildings and areas, but by 31st December 2014, Member States should require a minimum level of energy from renewables in all new buildings (and existing buildings subject to major renovation), and implement mechanisms to allow this to be achieved (whilst considering existing legislation and support mechanisms). The EPBD 'Nearly-Zero Energy Buildings' provisions support and build upon this minimum renewables criterion. It requires that all new buildings owned and occupied by public authorities by 31st December 2018, and by 31st December 2020 for all new-build private buildings, require 'nearly zero' energy, with the remainder covered 'very significantly' by renewables. The RED requires that the details of support schemes for renewables should be publicised to builders, installers and consumers, which increases the likelihood of the inclusion of renewables – under the support of relevant mechanisms – in new buildings and renovations, prior to these minimum requirements. The additional RED provisions of removing the administrative barriers, guaranteed access to the grid (in the case of installations making use of a feed-in tariff), and establishment of an installer certification scheme further reduces the barriers to renewable installations, even where they are not yet legally required. The CCS Directive experiences a neutral relationship with all other instruments described, aside from a small, weakly supportive link with the EU-ETS. The NER300 programme, funded by the sale of Phase 3 EU-ETS New Entrant Reserves, provides funding for demonstration of CCS technologies, advancing the cause of CCS technology alongside the legal framework provided by the CCS Directive.

Implementation Network/Administrative Infrastructure

Five of the seven instruments in this landscape are under the responsibility of DG CLIMA (EU-ETS, ESD, CO_2 emission standards and labelling for cars and CCS Directive), whilst the remaining two (EPBD and RED), fall under DG Energy. Due to the significant overlap with the EE&EC landscape, environment and energy departments remain the most prominent at Member State level. However, there is increased involvement from economic and industry departments, especially in administering the CCS Directive.

1.3.4 Non-Carbon Dioxide Greenhouse Gas Emissions

Objectives

The EU-ETS places a cap on CO_2 from electricity and heating production, along with other key energy-intensive industry, but also N_2O from nitric, adipic and glyoxalic acid production, and perfluorocarbons from aluminium production. The ESD aims to reduce GHG emissions (the six key GHGs identified by the Kyoto Protocol), from most of the remainder of the economy. Two of the four remaining instruments in this policy landscape have the explicit objective of reducing the emissions of non-CO_2 GHGs. The F-Gas Regulations aim to contain, prevent and reduce the emissions of f-gasses, as listed in Annex A to the Kyoto Protocol. The Landfill Directive aims to prevent or reduce negative effects on the environment, in particular the pollution of surface water, soil, air and the global environment – including the greenhouse effect, referring to the emission of landfill gas (methane).

The remaining two instruments do not hold GHG emission reduction as a primary objective, but this is a clearly a considered impact. The Nitrates Directive aims primarily at protecting water quality by preventing surface and groundwater pollution caused or induced by nitrates from agricultural sources through the promotion of good farming practices. The LULUCF Accounting Rules aim to establish robust common accounting, monitoring and reporting rules for LULUCF in the EU, as a precursor to including LULUCF emissions in overarching emission reduction targets.

Scope and Coverage

As discussed, the EU-ETS and ESD between them cover most of the economy, with the key exceptions of LULUCF and international shipping. The recent LULUCF Accounting Rules begin to rectify the lack of previous attention to this important sector. Again, the remaining three instruments are rather more specific in their sectoral and product coverage. The F-Gas Regulations places obligations upon the manufacturers, importers, exporters, suppliers, commercial operators and disposers of (primarily) refrigeration, air conditioning, heat pumps and fire protection systems that contain f-gases. The Nitrates Directive also focuses on agriculture – specifically those falling within an NVZ, but also all agriculture on a voluntary basis. The Landfill Directive directly holds the operators of landfills in its scope, along with the bodies responsible for the collection and disposal of biodegradable municipal waste (usually local government), but with a design to indirectly impact the wider economy – especially domestic producers of waste.

GHG coverage in this policy landscape is expectantly broader than other landscapes. The ESD has the broadest coverage, as it considers all six Kyoto GHGs – CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The EU-ETS focuses mainly on CO_2, but also N_2O and perfluorocarbons from specific sources, whilst the LULUCF Accounting Rules require CO_2, CH_4 and N_2O emissions are accounted. The F-Gas Regulations also cover three of the six - hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, whereas the Nitrates and Landfill Directives focus indirectly on a single GHG each – N_2O and CH_4, respectively.

Functioning and Influencing Mechanisms

Whilst the EU-ETS has a neutral relationship to all instruments in this landscape (concerning non-CO_2 GHGs), the ESD, Nitrates Directive and LULUCF instruments are mutually supportive. As stated, the ESD is an overarching instrument, which requires other instruments to fulfil its targets. The Nitrates Directive is one such instrument, and tackles N_2O emissions in agriculture. The LULUCF Accounting Rules supports and is supported by this Directive, as N_2O emissions from land under grazing and crop management (along with CO_2 and CH_4), must be accounted at the national level. Once LULUCF emissions are considered in overarching emission reduction targets, this relationship is likely to strengthen.

The F-Gas Regulations and Landfill Directive also support achievement of the ESD targets, but generally experience a neutral relationship with each other and other instruments – aside from the Landfill Directive and Nitrates Directive. The former encourages the diversion of

biodegradable municipal waste from landfill to other end uses, including compost. This compost is often used in agricultural purposes, reducing the use of synthetic nitrate fertilisers, helping to meet the requirements of the latter Directive.

Implementation Network/Administrative Infrastructure

Again, DG CLIMA is the primary Commission department responsible for the instruments in this landscape (EU-ETS, ESD, F-Gas Regulations and LULUCF Accounting Rules). DG Environment is also present for the first time, and is responsible for the Landfill and Nitrates Directives. National environment departments are prevalent in the administration of these instruments – especially for the Landfill Directive, Nitrates Directive and LULUCF Accounting Rules. Other departments are also involved in the administration of individual instruments dependent on the specifics of their implementation. For example, taxation authorities are involved in the Landfill directive where the use of taxes is employed.

1.4 Description and evaluation of policy landscapes in the light of the concept of optimality developed in task 1.1

This section discusses and evaluates the policy landscapes in the light of the concept of optimality developed as part of the CECILIA2050 project. The major elements of optimality are environmental effectiveness, cost-efficiency and feasibility, as defined in the CECILIA2050 Task 1.1 output report.

1.4.1 Carbon Pricing

The effectiveness of the Carbon Pricing policy landscape is relatively low. Whilst the EU-ETS may be considered effective upon initial inspection, it is not in the literature clear to what extent emissions reductions have been achieved through the instrument itself, or through a decrease in production as a result of the economic situation. The ETD works against the EU-ETS, as it provides skewed incentives to consume fuels of high-carbon intensity, and arguably does little to achieve it's primary objective of ensuring effective functioning of the internal market, as a significant proportion of Member States impose tax rates above the minima, producing uneven costs. The imposition of the proposed revision of the ETD, however, would significantly increase the effectiveness of this instrument, and of the Carbon Pricing landscape as a whole.

Economic instruments such as carbon pricing generally experience high static and dynamic efficiency. However, the actual design of instruments and their interaction in this landscape does little to achieve this potential. There is a lack of equalised marginal abatement cost stemming from within the ETD (both across energy products – varying from €1.1tCO_2 to €145tCO_2 - and between Member States), and thus between the ETD and EU-ETS. The overlap of the instruments also produces a double-cost to some sectors (i.e. most end-users of electricity), and explicit exemptions from either instrument to others (e.g. agriculture, domestic heating and non-ETS energy-intensive industry). Whilst there is broad sectoral coverage of both instruments, the lack of comprehensive coverage means these instruments cannot be fully statically efficient, although full coverage would bring difficulties, such as including sectors with vastly different emission profiles, and an extremely complex administrative challenge.

The lack of a consistent implicit carbon price (or price per unit of energy) in the ETD, coupled with the extremely low explicit carbon price signal currently experienced in the EU-ETS generally fails to stimulate investment, innovation and deployment of low-carbon technologies, thus failing to reduce the long-term cost of emissions abatement. The proposed ETD recast would significantly increase the static efficiency of this interaction, as the CO_2 'component' would track the EU-ETS price, and would remove some overlap and key exemptions. However, without reform to the EU-ETS, it likely that dynamic efficiency would remain low.

The administrative feasibility for this landscape is relatively high. Whilst the ETD is a simple tax, the EU-ETS requires a more complex administrative structure. Whilst this has experienced some issues (e.g. theft, VAT fraud), implementation has been generally effective, and continues to improve through the Phase 3 processes becoming increasingly centralised at EU level, and the introduction of an 'opt-out' mechanism for small emitters, with the aim of reducing administrative burden on emitters of negligible importance. The political acceptability of the EU-ETS is highly varied across Member States, depending on economic composition, and therefore perceived differences in cost burden. This is reflected in many (what may be considered) compromises in, for example, the proportion of allowances grandfathered and significant resistance to even relatively minor reform. Whilst the ETD requires very little flexibility in its current structure to deal with uncertainty, flexibility is a key theoretical feature of a cap-and-trade system. However, it is evident that the EU-ETS is not flexible enough to deal with the impacts of large-scale disruption, such as economic downturns and recessions. The lack of an inherent price management mechanism (by any means – e.g. price floor and ceiling, ability to centrally remove and retire allowances, etc.) is lacking, and requires a qualified majority agreement to put in place. If proposed structural reforms are passed, the ability of the EU-ETS to deal with future uncertainty would increase.

This links to the legal feasibility of the instruments in this landscape. Whilst the EU-ETS requires a qualified majority to implement changes, the ETD requires unanimity. Any instrument considered as taxation requires this consensus agreement, and therefore the result often lacks ambition in order to be accepted by all parties. The EU-ETS is considered an environmental policy and thus requires only a qualified majority to introduce or amend, however this still requires wide acceptance in order to achieve passage to legislation.

1.4.2 Energy Efficiency and Energy Consumption

Broadly speaking, the instruments in this landscape appear to be relatively effective in achieving their objectives, although the extent to which this is true varies significantly by instrument. Additionally, most instruments have objectives that only indirectly impact GHG emissions, meaning that achieving these objectives is not necessarily indicative of effectiveness in emission reduction. Assessing the effectiveness of these instruments suffers from several issues, including instruments that are very new or have long-term targets against which achievement cannot yet be assessed, and those which have significant confounding factors. Whilst this is not unique to the instruments in this landscape, it appears amplified. The effectiveness of the EU-ETS and ETD has been discussed. The ESD and EED are the two remaining broad-scope instruments in this policy landscape, and are also the newest. The ESD imposes binding national GHG emission caps for non-ETS sectors, but requires other

instruments to fulfil these ambitions. However, the European Environment Agency (2012) concludes that only six Member States will be required to impose additional policies to meet their targets by 2020, making achievement of these apparently low-impact targets likely, despite a lack of clear penalties for non-compliance. Conversely, the EED's imposition of binding *measures* rather than *targets* is likely to be a key reason that led the European Environment Agency (2013c) to suggest that stronger implementation of imposed measures, alongside new instruments, are likely to be required to meet the energy efficiency portion of the '20-20-20' targets.

The remaining instruments have a more specific scope - buildings, energy-related products and cars. Each of these three 'target groups' are subject to both a 'push' mechanism (minimum energy or carbon performance standards), and a 'pull' mechanism (labelling). For buildings, both aspects are provided by the EPBD. For energy-related products and cars, two separate instruments implement these aspects (Ecodesign and Energy Labelling Directives, and CO_2 emission standards and CO_2 labelling for passenger cars, respectively). Whilst the Commission's impact assessment for the EPBD projects annual energy and CO_2 reductions of up to 6% and 5% respectively against the counterfactual by 2020, there is little discussion in the literature regarding the effectiveness of the EPBD in promoting building energy efficiency (and emissions mitigation, by proxy), thus far. Significant evidence exists for increasing energy efficiency in the markets for energy-related products covered by the Ecodesign and Energy Labelling Directive, although the division of this achievement between the two instruments is difficult to ascertain. Whilst Waide & Watson (2013) cite energy labelling as the most important factor in driving efficiency (despite a reduction since the 2010 recast), CSES (2012) estimates energy savings of 355TWh by 2020 (around 14% average household consumption in 2009), derived from the Ecodesign Directive. Regarding the successful reduction of CO_2 intensity of passenger cars over recent years, the evidence is only a little clearer regarding the individual effectiveness of the two instruments concerned. Whilst CO_2 labelling appears to have had negligible impact, this achievement cannot necessarily be attributed entirely to emission standards, as the observed trend began prior to its introduction. In addition, these instruments tackle the CO_2 intensity of passenger vehicles rather overall production, and thus their overall impact on vehicle emissions may be relatively limited.

Static efficiency in this landscape is low. Focussing on CO_2 abatement, whilst the EU-ETS sectors are subject to an equal abatement incentive, the non-traded sector is not. This is in part due to the ESD emission caps being set at a national rather than EU level (albeit with estimates of abatement costs considered for each Member State, and with limited trading possible), and the lack of a single mechanism (e.g. cap-and-trade), from which an equal cost may arise. The remaining instruments (directly) impact largely the non-traded sector, although the ETD and EED experience some overlap (although, any instrument which works to reduce electricity consumption will impact the traded sector indirectly). The cost-efficiency of the former has been discussed. The latter instrument also imposes national-level (non-binding) targets, and also specific command-and-control measures (e.g. energy saving obligation, public sector requirements). This is also the case for the more sector-specific instruments, such as EPBD, Ecodesign Directive and CO_2 emission standards for cars. These measures impose minimum standards, which produce a given implicit cost for the energy saved and thus emissions abated. Although evidence is lacking in the literature for what these costs may be for many of these instruments, they are likely to be very different within themselves (e.g.

between Member States), and between each other. Some sectors will experience an overlap of these costs – building energy use (both public and private), is one such example (obligated under the EED, EPBD, and Ecodesign Directive to an extent). Emission (or energy) reductions are therefore not likely to be achieved in the cheapest manner possible, producing this low efficiency. Additionally, only the ESD concerns the six key GHGs, whilst all others concern CO_2 only (either directly or indirectly). The imposition of such minimum standards (with a lack of incentive to continually improve) also produces low dynamic efficiency. The two instruments that may help to encourage dynamic efficiency by providing an incentive to improve (Energy Labelling Directive and CO_2 labelling for cars) are limited in scope and impact, as previously discussed.

The administrative feasibility of these instruments has been mixed, despite the relatively high level of political acceptance and flexibility they contain. For the ESD and ETD this has been discussed. As might be expected, instruments with few specific or wide-ranging requirements have proven the easiest to implement and experience low levels of non-compliance, including the ESD and CO_2 labelling of cars. This does not necessarily extend to the Energy Labelling Directive, as many Member States do not (or are unable to) invest in suitable monitoring activities. Regarding the EED, national measures that are additional to the specific provisions it contains (which are required to meet indicative targets), may experience significant political opposition and administrative challenges, especially when a range of government departments must be involved (energy, domestic, infrastructure, industry, etc.). The Ecodesign Directive and CO_2 standards for cars have both been successful in their implementation. This is possibly due to the EU-wide harmonised requirements produced by these instruments, and the fact that they are imposed directly upon the relevant sector, rather than at government level, with clear incentives for compliance (e.g. fines, reputational risk, etc.). The EPBD has experienced difficulty, especially in Member States with no precedent in similar legislation. This is compounded by the relative complexity of the provisions of this instrument, and the monitoring effort required in ensuring compliance.

1.4.3 Promotion of Renewable Sources of Energy

In 2010, the share of energy consumption in the EU from renewable sources was 12.7% - ahead of the 2011//12 target of 10% (set by the RED). This indicates that the instruments in this landscape are achieving this overarching goal, set by the RED as the overarching instrument. However, the contributions of individual instruments within this landscape in achieving this level of renewable penetration, or their interactions, are unclear. Whilst twenty-four countries had already met their overall 2011/12 renewable energy targets by 2010, fifteen Member States failed to meet indicative targets for renewable electricity. Aside from national mechanisms designed to increase renewable electricity under the RED, the EU-ETS plays a role in encouraging renewables in this sector. However, increasing renewables in the large electricity generation sector (regardless of the instrument under which they are induced) does not produce emissions mitigation in the traded sector, as these avoided emissions are then permitted elsewhere (either in another Member State, traded-sector industry, or both) – although this was anticipated in the cap-setting calculations for the EU-ETS. This emission 'leakage' applies to an extent however to the promotion of renewables in the non-traded sector, under the ESD, for example in encouraging renewables in buildings. In the transport sector, alongside national RED mechanisms, the CO_2 emission standards and labelling for

cars promotes renewables – particularly biofuels. Although the proportion of biofuel use is increasing, twenty-two states failed to meet the 2010 target of 5.75% biofuels in transport energy. However, the effectiveness of using biofuel in emission mitigation is questionable. The RED also encourages the production of distributed microgeneration of both electricity and heat, alongside the EPBD. Again, the division of a relatively small achievement seen thus far in this sector is difficult to determine. Despite the overall success in increasing renewables penetration, the Commission estimates future difficulties in reaching the 2020 target embodied in the RED, in significant part due to difficulty of instrument implementation, discussed below.

Again, despite the wide sectoral coverage provided by the EU-ETS and ESD (and the economy-wide coverage of the RED), this policy landscape is statically inefficient. The setting of national specific targets for renewables does not necessarily achieve deployment in the most cost-effective regions or manner, as different mechanisms may be imposed to achieve these targets. The overlap of these targets with the price incentive from the EU-ETS further distorts the market, as RES support mechanisms generally impose a higher implicit cost of carbon than the EU-ETS alone would generate. The RED also effectively produces different implicit costs of carbon from renewable installations between regions (which the design of the EU-ETS intended to avoid). This extends to the RED 10% renewable transport target in 2020, which produces an implicit cost of abatement different to that resulting from CO_2 emission standards, both under the ESD. The overlap between RED incentives for microgeneration (e.g. feed-in tariffs) and upcoming requirements for renewable energy installations in buildings (e.g. near-zero energy buildings) produces a similar distortion. As such, the marginal abatement cost across the economy resulting from these instruments is varied. Again, aside from the ESD (and EU-ETS to an extent), CO_2 is the only GHG (directly or indirectly) within the scope of these instruments (although, this is a reasonable expectation). The dynamic efficiency of this landscape is relatively mixed, as whilst there is no incentive to exceed the targets set by the RED, in particular (the only dynamic incentive may come from the EU-ETS in the large electricity generation sector, although without structural reform this incentive is minimal), a significant level of innovation and diffusion of renewable technologies, along with cost-reductions, is reasonably expected – reducing the cost of abatement in the future.

The feasibility of most of these instruments was discussed under the EE&EC landscape. The RED has experienced relatively significant issues regarding administrative feasibility. Provisions which require the streamlining of administrative procedures for permitting renewable installations and grid infrastructure are being introduced only slowly, with arguably only five Member States having successfully achieved it. The Commission cited this trend as a key concern for the future growth of renewables. The CCS Directive, which has not featured in this discussion thus far, also appears administratively difficult, as twenty-five Member States failed to transpose its provisions by the deadline of 25th June 2011.

1.4.4 Non-Carbon Dioxide Greenhouse Gas Emissions

The effectiveness of the instruments in this policy landscape is generally high. The ESD has been discussed previously, whilst the EU-ETS has only minor non-CO_2 interest. The F-Gas Regulations, Landfill Directive and Nitrates Directive are all command-and-control instruments that impose bans on products or activities, technical requirements and binding targets. All three instruments have been successful in achieving their objectives from this point of view,

however only the F-Gas Regulations are concerned with direct emissions abatement. Despite this, emissions that fall within the scope of these instruments have decreased significantly - in particular N_2O under the Nitrates Directive. However, the limited scope of these instruments (in terms of both GHG and sectors or products), limit their impact. The LULUCF Accounting Rules are very new, and thus it is too early to estimate its effect, although, little abatement is expected from this instrument as it stands as it is simply an accounting framework.

This limited sectoral, product and (largely indirect) GHG scope again produces low static efficiency. Despite the lack of supporting evidence in the literature, it is likely that each instrument produces very different implicit carbon (equivalent) costs from the abatement achieved. Dynamic efficiency is also low, as there is little incentive to go beyond minimum requirements. This may change in future for the F-Gas Regulations at least, if proposed amendments are accepted. The effectiveness of these instruments is largely a result of political acceptance and effective administrative implementation (despite issues with some aspects of the F-Gas Regulations).

2 Description and initial evaluation of the overall instrument mix

2.1 Identification and description of the main interactions between policy landscapes

This section identifies the main interactions between policy instruments between policy landscapes, focusing on (1) objectives and sub-objectives; (2) scope and coverage; (3) functioning and influencing mechanisms; and (4) administrative implementation. A full description of interactions is given in Annex 2.

Objectives

As there is relatively significant overlap of policy instruments between policy landscapes, much of the discussion of supporting and conflicting objectives has been discussed. However, this section may draw out some overall trends. As nine of the fifteen policy instruments discussed in this paper fall under the EE&EC landscape (seven as their primary classification), this may be considered the primary policy landscape, against which the broad objectives of other landscapes may be compared. Five of the nine instruments in the EC&EC landscape hold emission mitigation as an explicit primary objective, to be achieved either in part of in whole through the promotion of energy efficiency. These are the EU-ETS, the ESD, EPBD, CO_2 emission standards for passenger vehicles, and CO_2 labelling of passenger vehicles. Two of the nine (the EED and Energy Labelling Directive), hold energy efficiency as the end goal, but with an obvious desired impact of emission mitigation. The remaining two – the ETD and Ecodesign Directive – aim to ensure the effective functioning of the internal market as their primary objective, with energy efficiency as a secondary consideration.

The Carbon Pricing landscape (EU-ETS and ETD) fits within the EE&EC landscape entirely, and only matches with the general trend of emission mitigation as the foremost objective of the EC&EC landscape through the EU-ETS. The EU-ETS is the key instrument in the Carbon Pricing landscape, and across the EU climate policy landscape as a whole. The Promotion of

Renewables landscape shares five of its seven instrument with the EC&EC landscape, with only the remaining two (RED and CCS Directive) holding the Renewables landscape as their primary classification. The five instruments that overlap with the EC&EC landscape are the five that hold emissions mitigation as their stated objective (to be achieved through the promotion of renewables, alongside energy efficiency), however the RED – the key instrument in the Promotion of Renewables landscape, holds achieving the second pillar of the '20-20-20' targets – raising the share of EU final energy consumption produced from renewable resources to 20% - as its primary objective, with emission mitigation as an indirect impact. Four of the six instruments in the Non-CO_2 GHG policy landscape hold emission mitigation as their primary purpose, including the EU-ETS and ESD, which overlap with both the EC&EC and Promotion of Renewables landscapes. The remaining two instruments (Nitrates Directive and LULUCF Accounting Rules) do not hold GHG emission reduction as a primary objective, but this is clearly a designed impact.

The Carbon Pricing Landscape also overlaps with the Promotion of Renewables and Non-CO_2 GHG landscapes through the EU-ETS. As this is the key instrument in the Carbon Pricing landscape, it may be considered in line with the objectives of these Renewables and Non-CO_2 landscapes through the 'emission mitigation' stated objective. The Renewables and Non-CO_2 GHG landscapes may also be considered broadly aligned through this objective, assisted by the overlapping of the EU-ETS and ESD between these two landscapes.

In summary, whilst fourteen of the fifteen instruments discussed have a designed, expected and desired impact on emissions mitigation, only seven of the fifteen instruments discussed in this paper cite the abatement of GHG emissions to be a primary objective (EU-ETS, ESD, EPBD, CO_2 emission standards for passenger vehicles, CO_2 labelling of passenger vehicles, F-Gas Regulations and the Landfill Directive), to be achieved through either the pricing of CO_2, the promotion of energy efficiency or renewables, or the direct restriction of emitting activities. Four of these fourteen instruments focus on such aspects indirectly, and achieve emission reductions through enhancements in energy efficiency, (Energy Labelling Directive, Energy Efficiency Directive), promotion of renewables (RED), and product efficiency (Nitrates Directive). Two of the remaining three instruments (CCS Directive and LULUCF Accounting Rules), aim to enable mitigation through the removal of administrative, legal and other uncertainties, to allow other instruments (those discussed here, and more widely), to function effectively.

The Ecodesign Directive is the final of the fourteen instruments discussed that have emission mitigation as an expected impact, but not as a primary objective. This Directive holds the effective functioning of the internal market as its primary objective, with the promotion of energy efficiency as a secondary aim.

This matches with the hierarchy of objectives of the ETD, the final instrument of the fifteen. It is the only instrument discussed that does not appear to have an designed impact on emission mitigation – or indeed energy efficiency – based on its current design. The proposed amendment to the ETD would change this, however. Additionally, the advancement of energy security would likely be a result of most of the instruments discussed in achieving their aims (especially from the EE&EC and Promotion of Renewables landscapes), and this is stated as an explicit secondary objective in the ESD and Ecodesign Directive.

Scope and Coverage

Each policy landscape has broad and significantly overlapping direct target groups. As such, for ease of discussion, interactions shall be described by key target group. This is not necessarily the group upon which the direct or indirect cost or burden of an instrument falls, but which sector is the target of the instrument's direct impact. Subsequent secondary interactions between target groups shall be discussed in the following sub-section.

The large-scale electricity and heat production sectors (>20MW rated thermal input) are only directly subject to the EU-ETS and the RED. The former places a cost on CO_2 emissions, encouraging efficiency and a shift to low-carbon generation. The latter also aims to promote low-carbon generation amongst large-scale electricity suppliers, in addition to microgeneration across the rest of the economy, and amongst non-electrical energy generators and suppliers (e.g. transport fuels). The EPBD also encourages the distributed generation of renewable electricity and other energy. The EED holds large-scale electricity and heat producers and suppliers partially within its scope, by promoting the use of high-efficiency co-generation, and obliging suppliers to achieve savings in the volume of energy they supply. The ETD also applies to large-scale heat production, but provides an exemption to electricity production and CHP installations. The CCS Directive also indirectly applies to these sectors.

Energy-intensive industry also largely falls within the scope of the EU-ETS and often the EED, with the latter requiring all large companies (>250 employees and exceeding €50 million), to undertake independent energy audits from 5th December 2015. This requirement will also cover many organisations in the non-energy intensive sector. The CCS Directive may also indirectly apply to some energy-intensive industry, along with the F-Gas Regulations. The ETD affords Member States the ability to apply full tax exemptions for energy products used for heating and the operation of stationary motors and machinery in energy-intensive industry, when other agreements or regulations are in place to deliver similar results.

All other sectors are subject to the ESD, as an overarching target for non-ETS sectors. The public, non-energy intensive private and domestic sectors are subject to different degrees to the EPBD, Ecodesign Directive, Energy Labelling Directive, Energy Efficiency Directive, the RED, F-Gas Regulations, Landfill Directive and the ETD. The ETD applies to the consumption of energy products in most non-energy-intensive sectors, however exemptions may be granted to energy products used in domestic heating (including electricity). The EPBD concerns all new buildings, existing buildings undergoing refurbishment, and any building being sold or rented, under different provisions. This includes minimum energy performance standards, energy performance certificate requirements, 'near-zero energy' provisions and consideration of renewables. This final aspect overlaps with the RED, which seeks to encourage the development of microgeneration through both voluntary and mandatory means in both the domestic and non-domestic sectors. The Ecodesign and Energy Labelling Directives govern energy-related products within buildings (from boilers and air-conditioners, to washing machines and televisions), overlapping with the EPBD requirement for inspections of large heating and air-conditioning systems. Many products, such as air conditioners and refrigerators, are also governed by F-Gas Regulations. The EED also governs domestic and non-domestic buildings. Central government is required to purchase products, buildings and services of high energy performance, whereas all end users of electricity and natural gas must

receive smart meters upon replacement of an old meter, when a new connection is made or when a major renovation is undertaken, to enable accurate billing and information provision. The Landfill Directive, whilst not directly applicable to the domestic sector in its provisions, specifically targets the reduction of biodegradable municipal waste, and thus holds the domestic sector within its general scope.

The transport sector (broadly defined) is subject the ETD, RED, CO_2 emission standards and labelling for passenger cars, and the EU-ETS – however this is only applicable to aviation. The scope for CO_2 emission standards and labelling for passenger cars is self-evident. The ETD places minimum taxation on motor fuels, whilst the RED aims to raise the penetration of renewable energy in transport to 10% by 2020 – principally through increasing use of biofuels. F-gas Regulations also touch upon the transport sector, as it prohibits the use of f-gasses in tyres. International shipping is explicitly excluded from the ESD and may be exempt under the ETD, along with international aviation. The remaining key sector under the ESD is agriculture, which is subject to the Nitrates Directive and LULUCF Accounting Rules. Agriculture may also receive an exemption from obligations under the ETD.

Only six of the fifteen policy instruments described in this paper have direct coverage of GHG emissions – the ESD, EU-ETS, CO_2 Emission Standards and Labelling for Passenger Cars, F-Gas Regulations and LULUCF Accounting Rules. The ESD concerns all six Kyoto GHGs, whilst the subsequent three concern principally CO_2, with the EU-ETS also covering N_2O and perfluorocarbons to a limited extent. The LULUCF Accounting Rules also cover N_2O and perfluorocarbons (alongside CO_2) whilst F-Gas Regulations concern hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. A seventh instrument, the CCS Directive, may also be considered directly concerned with CO_2 emissions, but it is not directly concerned with its mitigation. The remaining instruments impact GHG emissions indirectly. Six of the remaining eight instruments focus on CO_2 (ETD, EPBD, Ecodesign Directive, Energy Labelling Directive, EED and the RED), whilst the remaining two – Nitrates Directive and Landfill Directive – focus indirectly on N_2O and CH_4, respectively.

Functioning and Influencing Mechanisms

As the two instruments in the Carbon Pricing landscape also fall within the EE&EC landscape, their interactions have been discussed. Broadly speaking, a price on carbon provides incentive for carbon and energy efficiency. This is generally true with the EU-ETS and its relationship with other instruments in the EE&EC landscape, but the current design of the ETD produces a conflicting relationship. This description also holds to between the Carbon Pricing and Promotion of Renewables landscape. Whilst the relationship is relatively neutral regarding the production of renewable electricity (renewable and fossil fuel sources electricity are taxed at the same rate), the use of renewables in other sectors – such as transport and heating - are discriminated against. Biodiesel, for example, typically holds a lower energy density than diesel. As the ETD currently taxes both commodities at the same rate, based on volume, biodiesel experiences a higher tax burden per unit of energy. The proposed revision of the ETD would correct this conflict, and even proposes a direct link – with biofuel only experiencing an exemption under the CO_2 'portion' of the tax if it meets the RED sustainability criteria.

The functioning of the instruments in the EE&EC and Promotion of Renewables landscapes are highly supportive, as has been largely discussed regarding the significant overlap in instruments. Some interactions remain which lie outside these overlapping instruments. For example, national Renewable Energy Action Plans under the RED must consider planned and pre-existing energy efficiency measures – including those introduced under the EED (enacted in 2012 – after the RED in 2009). This support is reciprocal; the EED requires the installation of smart meters in new buildings and those undergoing significant refurbishment (also 'encouraged' under the EPBD), which enable microgenerators to supply power to the grid. This has obvious benefits for the RED, which also provides guaranteed access to the grid for renewable installations, alongside mandating the development of transmissions and intelligent grid infrastructure to enable the management of increasing centralised and distributed renewable electricity generation. The EED also contains provisions for high-priority access to the grid for high-efficiency cogeneration, which when biomass in particular is used in such installations, is highly supportive of the RED.

There is a largely neutral relationship between the EE&EC and Non-CO_2 GHG landscapes. Aside from the overlap with other landscapes delivered by the EU-ETS and ESD however, a key relationship is between the Ecodesign and Energy Labelling Directives, and F-Gas Regulations. Key products, such as air-conditioners and refrigeration equipment, are regulated by all three instruments – and are supportive in reducing the environmental impact of these products. The proposed amendments to the F-Gas Regulation include a ban on certain products with HFCs with a GWP of over 150, beginning with domestic refrigerators and freezers in 2015, followed by commercial refrigerators and freezers and movable room air-conditioning appliances by 2020. A ban on commercial refrigerators and freezers containing HFCs with a GWP over 2,500 is proposed with effect from 2017. The proposals may alter the energy consumption profile of the market for these products, altering the premise upon which the Ecodesign and Energy Labelling Directive regulations for these products are based. However, if the Commission decides to pursue a lifecycle approach in labelling in the future, this relationship would likely become even more supportive.

Whilst there is an almost entirely neutral relationship between the Carbon Pricing and Non-CO_2 landscapes (aside from the EU-ETS and ESD overlap, as previously discussed), there is a generally supportive relationship between the latter policy landscape and the Promotion of Renewables instruments. The use of agricultural waste for the production of energy (e.g. biogas) is incentivised by the RED and the Landfill Directive, with the latter doing so indirectly through disincentivising landfilling. However, there is also a conflict between these two instruments, as the latter encourages the reduction of biodegradable waste in landfills, reducing the production of landfill gas that is incentivised through the RED. The LULUCF Accounting Rules is supportive of any instrument that encourages the use of biomass or biofuels (particularly the RED, and CO_2 emission standards and labelling of cars, but also the EU-ETS, ESD and EPBD, and in future possibly the ETD). Full accounting of the emissions involved in the production of biomass would be considered (although only for domestically produced biomass), allowing for a more comprehensive of biomass sustainability and potential elimination of accounting the use of biomass as zero-emissions.

Implementation Network/Administrative Infrastructure

At the EU level, DG CLIMA is the Directorate-General with the most responsibility for the instruments in the four climate policy landscapes (as might be expected), holding responsibility for seven of the fifteen instruments discussed (EU-ETS, ESD, CO_2 emission standards for passenger cars, CO_2 labelling for passenger cars, CCS Directive, F-Gas Regulations and LULUCF Accounting Rules). DG Energy is the second most prevalent, although with only three instruments falling under its remit (EED, EPBD, and RED). Directorate-Generals without a direct climate change, energy or environment remit are also concerned with climate policy instruments, reflecting the broad approaches and sectoral nature of the instruments employed to tackle GHG emissions. This includes DG Enterprise and Industry (Ecodesign and Energy Labelling Directives), and DG Taxation and Customs (ETD). The level of integration and consultation between these Directorate-Generals varies by instrument. However, a unifying body is the European Environment Agency, which is tasked with collecting data and assessing the effectiveness of environmental instruments. This analysis assists in determining the impact of overlap and interaction between these instruments (often using data and analysis provided by Member States), to allow conclusions to be drawn on possible amendments, additions or removals of certain provisions in different instruments.

Whilst the above Directorate-Generals hold oversight over these instruments, the emphasis is on competent authorities within Member States to implement their provisions. At the national level, departments, ministries and executive bodies responsible for the environment an energy matters are the most prevalent competent authorities, as might be expected. Business, industry and economic authorities, including taxation authorities, are also present – as are different levels of government (e.g. central, regional and local). The administrative infrastructure, along with interactions between them, depends significantly on the instrument and Member State, largely owing to the relatively significant level of flexibility afforded to Member States in discharging their obligations.

2.2 Summary discussion of the combination of policy landscapes (the overall instrument mix) against each one of the elements of the concept of optimality

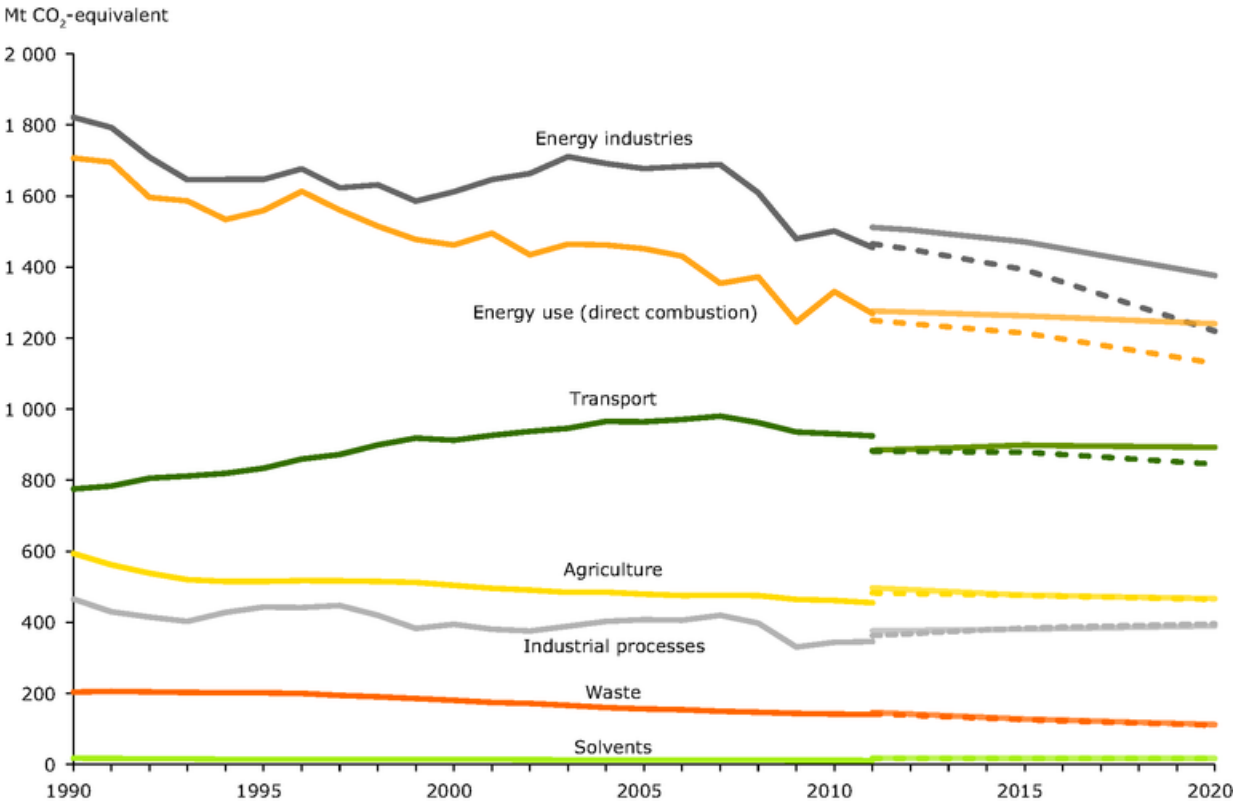
Environmental Effectiveness

GHG emissions in the EU27 (excluding LULUCF) reduced by around 18.4% between 1990 and 2011 (European Environment Agency, 2013b). Figure 7 provides a sectoral breakdown of this reduction (European Environment Agency, 2012), with projections to 2020 (solid line = With Existing Measures (WEM), dotted line = With Additional (planned) Measures (WAM)).

A key contributor to this reduction (and largest GHG source) are ‘energy industries’, a majority component of which is the electricity production sector – subject directly to the EU-ETS and the RED (but also indirectly to most energy-efficiency instruments). Other sectors such as petroleum refining are included under ‘energy industries’, but are minor contributors in comparison. Both of these instruments appear to be achieving their objectives, however the extent to which they contributed to the emissions reduction in this sector is, again, unclear. Laing *et al* (2013) suggests the EU-ETS between 2005 and 2007 induced emissions

reductions of 2-4% (extending beyond the electricity generation sector). Although robust assessment of Phase 2 attributable savings is currently lacking, the onset of the financial crisis and consequent reduction in demand was a significant factor in the observed 'dip' towards the end of 2008 and into 2009, responsible for a 5% reduction in traded-sector emissions compared with 2005, and stabilising around this level until at least 2011 (European Environment Agency, 2012). As previously discussed, despite some success in promoting renewable electricity, it is unlikely that the RED itself induces any emission mitigation in the traded sector, as 'avoided' emissions from renewables are then permitted elsewhere, such as in the remainder of the electricity sector (through higher CO_2 intensity), or energy-intensive industry. However, this is not indicative of ineffectiveness as the promotion of renewables (with a desired effect producing dynamic cost reductions), is the objective of the RED, rather than direct emission mitigation.

Figure 7 - Sectoral trends and projections of EU GHG emissions (Source: European Environment Agency, 2012)



The 'energy use (direct combustion)' line largely equates to energy-intensive industry (covered by the EU-ETS), and other direct combustion (e.g. gas heating in buildings, influenced by the EED, EPBD, Ecodesign Directive, Energy Labelling Directive, and the RED). Emission reductions in this sector are clearly important in driving overall reductions, due to its size. The EU-ETS impact, discussed above, is also experienced by most energy-intensive industries, as was the 'dip' in traded sector emissions caused by the financial crisis. Whilst some instruments have been clearly successful (e.g. Ecodesign and Energy Labelling Directives), the overall success and effectiveness in inducing emissions mitigation for some instruments is unclear. Although, many of these instruments are relatively new (either absolutely or in their current

incarnation), and therefore assessment of effectiveness cannot yet be accurately undertaken. The 'industrial processes' line also relates largely to the energy-intensive sector, and is impacted by the F-Gas Regulations, which despite some implementation issues, delivered at least 3 million t/CO_2e savings between 2006 and 2010.

Both the 'energy industries' and 'energy use' sectors have experienced a generally steadily decreasing trend in emissions since 1990. As the instruments discussed in this paper have only been active largely since around the year 2000 (or significantly after), the case could be made that other factors drive this trend, as there is no noticeable change in the rate of emission reduction upon introduction of these instruments. Such factors may include the decreasing energy-intensity of ex-soviet economies (also the general continuing trend of deindustrialisation in Europe), or relative international cost variations in energy products of different carbon intensity, for example. Such factors are likely to play a role, but are unlikely to be sufficient. Many of the instruments discussed have precursors - previous incarnations of the same or similar legislation (e.g. EED), or Member State level legislation that was simply codified at EU-level to provide consistency (e.g. ETD). The current legislation may simply be continuing a trend at least partially driven by their precursors (or possibly improving upon it).

Conversely, the transport sector – covered by the ETD, RED, CO_2 emissions standards and CO_2 labelling of passenger cars - experienced a general increase in emissions to 2007, with a slow decrease thereafter. Despite the RED (previously Biofuels Directive) target of 5.75% biofuel in road transport by 2010 being missed by most Member States, it is reasonable to conclude that this instrument largely drove the increase that actually came to pass. CO_2 standards have been successful in achieving their goal of reducing CO_2 intensity of passenger cars through increasing dieselisation and decreasing engine capacity (although CO_2 labelling appears to have a negligible effect). However, this instrument deals only with emission intensity, and does little to tackle absolute demand. Other factors, such as capital costs and volatile petrol and diesel prices (in which biofuels are discriminated against by the ETD, but the effect is likely to be small or negligible), and from 2008, possibly a decrease in demand – commercial transport, in particular - induced by the financial crisis, are likely to have played a more influential role in emissions trends.

The effectiveness of the instruments discussed concerning waste (Landfill Directive) and agriculture (Nitrates Directive), appears relatively high. The Landfill Directive is a broad piece of legislation, which has reduced the number of landfills, and the volume of biodegradable waste (the primary source of landfill gas – methane), substantially. It may indeed be the primary driver of the gently decreasing trend in waste sector emissions illustrated in Figure 7. Whilst the RED incentivises the use of landfill gas, reducing fugitive emissions from the remaining biomaterial, this appears to as yet have no discernable impact on the overall trend. The Nitrates Directive, whilst a largely successful instrument in itself (producing 6.3% N_2O savings from agriculture in 2008, compared to the counterfactual – the upper end of estimated potential savings), produces little emission mitigation impact overall. These avoided N_2O emissions are an extremely small proportion of overall agricultural GHG emissions, which are dominated by methane produced by livestock. The LULUCF Accounting Rules, whilst another important instrument regarding agriculture, was only introduced in summer 2013, and thus has not yet had an impact against which to assess its effectiveness. Although, as an accounting framework and a precursor to emission mitigation efforts, it is likely to produce negligible GHG

reductions in itself. The ESD, as it only applies from 2013, is also too recently established to assess effectiveness.

In summary, the effectiveness of these key instruments in the EU's climate change policy mix in inducing GHG emission reduction appears mixed. The overall impact is difficult to determine, as the counterfactual cannot be known, and is made more difficult over time and by the introduction of system 'shocks', such as the financial crisis, which may shift the assessment baseline dramatically. Although assessing instruments individually helps in such an analysis, the problem remains. Additionally, whilst some instruments may not have achieved certain targets, for example, it is not to say they have not been successful in reducing emissions at all. Indeed, many instruments do not directly intend to reduce emissions, but rather to improve energy efficiency for example, of which emissions reduction is a desired impact, but is outside of its sphere of influence and cofounded by other factors.

Other instruments are very recent (many at least in their current design), and have yet to exercise their influence. Although some instruments may require alteration in order to meet long term (specifically 2020) targets, existing measures are likely to produce around 19% emission reductions below 1990 levels across the EU27 (excluding Croatia), just below the target of 20% (European Environment Agency, 2012). Although the combination of the EU-ETS and ESD obligations should achieve the full 20%, this estimate considers actual, existing national measures enacted to meet such overarching targets, rather than assuming automatic achievement. Additional, planned measures would likely meet the 20% target, although both scenarios are only a slight increase on what has already been achieved thus far (18.4%). It is reasonable to conclude that myriad other factors hold significant influence on emission trends, such as fuel prices, economic structure, behavioural issues and other policy priorities.

Economic Efficiency

An initial inspection of the EU's overall climate policy instrument mix may lead to the conclusion that its static and dynamic efficiency is relatively low. However, this is a rather simplistic view, and must be heavily caveated.

Whilst the combination of instruments discussed target most emission sources in the EU (directly or indirectly), there is a lack of an equalised economy-wide marginal abatement cost. Emissions in the EU are commonly divided into the 'traded' sector (covered by the EU-ETS – around 50% of total CO_2 emissions, equalling about 40% total GHG emissions), and 'non-traded' sector (the remaining 60% – covered by the ESD). Whilst the EU-ETS produces an equalised cost across its obligated sectors and Member States, the ESD does not. The ESD is not an active instrument in itself, and requires other measures to achieve its aims. It also sets caps at a national level, immediately producing varied total abatement costs across different Member States (although differentiated abatement costs were considered in the initial cap-setting, and there is an option for limited emission trading).

Most instruments discussed tackle emissions in the non-traded sector. Whilst some instruments impose EU-wide minimum standards for products, yielding an equalised abatement cost across these products (Ecodesign Directive, CO_2 standards for passenger cars and F-Gas Regulations), instruments such as the ETD, EED, EPBD, RED, Landfill

Directive and Nitrates Directive set prescriptive targets to be met, either equal across or differentiated between Member States. Whilst these targets often may be met using nationally appropriate measures, such prescriptions may distort abatement cost between Member States and sectors (e.g. meeting a 10% renewable transport target under the RED may cost more per tCO_2e abated than requiring further efficiency savings under the EED). Such prescriptions are statically inefficient, and inducing stacked incentives and obligations - sometimes counterproductively. Many of these instruments also overlap with the traded sector, either directly or indirectly. The RED and EED directly overlap, and place obligations on EU-ETS sectors (e.g. minimum renewable generation). Whilst these instruments are complementary to the goals of the EU-ETS, they are not strictly economically efficient in combination with it, as the obligations they impose may not produce the cheapest abatement that the EU-ETS market alone would theoretically produce. The ETD and EPBD (and also the Ecodesign Directive, to a lesser extent), overlap indirectly with the EU-ETS. The theoretical purpose of the EU-ETS is to internalise the CO_2 externality into the cost of the emitting process – chiefly electricity production. This price signal is passed to the final consumer, which would be expected to induce demand reduction to the 'optimal' level, via energy efficiency measures and the installation of cost-effective renewable technologies. The EPBD, for example, overlaps with this incentive by requiring efficiency and renewable installations under its 'nearly-zero carbon homes' requirement, possibly reducing emissions below the 'optimal' level, increasing overall costs unnecessarily.

Such arguments against such overlap assume a market in which actors have perfect knowledge, no transaction costs and the initial instrument is operating as it theoretically should (e.g. fully internalising the cost of the externality). This is usually not the case in the real world, and instruments and instrument mixes must make concessions to this, sometimes at the expense of strict economic efficiency, in order to be effective. This is discussed further under the ' instrument mix feasibility' section, below.

Despite the broad scope of the ESD, the 'implementing' instruments discussed are rather specific in their scope, and focus on a particular sector or emission source. Significant sources of emissions (e.g. agricultural CH_4 emissions from livestock), are not subject to EU-wide instruments, and are rarely tackled by Member States unilaterally, producing gaps in coverage. However, this is usually due to practical barriers. The LULUCF sector is also unrestricted, but the LULUCF Accounting Rules begin the process to rectify this.

A potential benefit of increased total current abatement costs, brought about through less-than-entire static efficiency, is increased dynamic efficiency, through which investment and innovation reduces the cost of future abatement. Some individual instruments appear to induce this effect and are intended to do so (e.g. RED), but overall, the effect of continued incentive to innovate and continually abate is difficult to identify in any significant measure. This may be due to the relatively short timeframe in which these instruments have been in place, although many instruments impose targets and provide relatively little incentive to continue abatement abate this level (either through direct or indirect abatement). Although many instruments impose steadily increasing targets, the time horizon of many of these policies (including the overarching EU-ETS and ESD, but also major instruments such as the RED and EED) stretches only to 2020, with significant uncertainty regarding subsequent obligations and incentives (although many national-level mechanisms, such as feed in tariffs or

other renewable obligations, provide support over this date). This is likely to be a significant barrier to significant investment in innovation in existing and new technologies, preventing full dynamic efficiency.

In summary, the static and dynamic cost-efficiency of the current climate policy instrument mix is relatively low. GHG abatement incentives and costs are generally varied across sectors and Member States. Whilst the literature lacks quantified evidence for the implicit carbon price of individual instruments, some sectors experience many 'stacked' costs and incentives for abatement, whilst others receive little to none. However, this must be taken in context of the political, legal, and administrative context within which these instruments were designed and operate, and the difference between theoretical operation of instruments and economic actors, and the reality.

Instrument Mix Feasibility

As most of the instruments discussed in this paper require qualified majority or even unanimous acceptance by all Member States, they are by definition politically feasible. The common practice of imposing differentiated national targets, and allowing flexibility of imposing nationally appropriate measures, is a result of several characteristics of EU law-making, including the principle of subsidiarity and the preservation of national sovereignty. Whilst this may inherently reduce the economic efficiency of such instruments, their operation must be balanced against such concerns. However, many instruments exhibit characteristics typical of compromise beyond that of simply applying such principles. This includes, for example, the lack of binding targets in the EED (opting for binding 'measures' instead), the extensive availability of derogations and exemptions available under many instruments (e.g. energy-intensive industry and domestic heating under ETD), and a lack of specific penalties for non-compliance in many instruments. Additionally, the prevalence of the caveat that certain obligations are only mandatory when 'cost-effective' provides significant scope for 'justified' non-compliance.

Some of these aspects arise from other priorities, which these instruments may be perceived to oppose (e.g. industrial competitiveness), and others may attempt to address issues such as distributional impact and excessive cost burden on certain groups (e.g. domestic sector). Other aspects may be simply ideological, including a lack of will to tackle climate change and emissions, and a belief in the principles of non-interference in some quarters. This final aspect became apparent in the recent efforts to impose even a minor, non-structural reform to the EU-ETS ('backloading'), in order to boost the carbon price, which passed on its second attempt through the European Parliament battling stiff opposition. This final aspect highlights an issue of a lack of general flexibility in some instruments to deal with uncertainty, such as a change in demand for a commodity (be it energy, industrial products, etc.), exemplified by the effects of the 2008 financial crisis. However, taking a wider view reveals that overall flexibility is generally high, with policy learning and adaptation in evidence through the recast and adjustment of several instruments over time, to correct previous failings.

The administrative feasibility of instruments has been mixed, both between individual instruments and Member States. Member States with no previous experience in similar legislation (e.g. building energy efficiency requirements) have experienced difficulty, as have

Member States with relatively weak institutional infrastructure or ability to conduct regular and comprehensive compliance exercises. This is connected to the capacity for data collection, analysis and reporting, a requirement of all instruments, and an aspect most reported as lacking amongst many Member States – especially towards the beginning on an instrument's introduction (again, linked to the presence of previous comparable policies).

In summary, whist there is evidence of political compromise in some instruments, reducing their initial ambition; climate policy instruments (along with all other instruments), are designed in the context of other priorities and restrictions, including legal, administrative and considerations of the practical response of actors upon which obligations or incentives are targeted. Whilst improvements may be made, and considering the complex objectives, operation and interaction of the instruments involved, the overall 'feasibility' of the current instrument mix is relatively high.

3 Conclusions

The EU has a range of climate policy instruments with varied objectives, targets groups and approaches to encourage the abatement of GHG emissions. The key instruments and interactions within each 'policy landscape' are:

- **Carbon Pricing** – The EU-ETS and the ETD experience little direct interaction (although there is some indirect overlap, on the production and consumption of electricity, for example). Their relationship is conflicting, as the design of the ETD produces incentive to consume carbon-intensive fuel (e.g. coal), over less carbon-intensive fuel (e.g. gas), for heating.

- **Energy Efficiency and Energy Consumption** – Along with the EU-ETS, the ESD and EED and are the key instruments in this landscape. The EU-ETS and ESD provide complimentary sectoral coverage, but unequal abatement incentives. The ESD is a 'framework' instrument reliant on other instruments to fulfil its objectives. This includes the EED, which places energy-saving obligations on energy generators, suppliers and end-users. The remaining instruments are more sector-specific and target buildings, energy-related products and transport. The latter two sectors are subject to two complimentary instruments each – the Ecodesign and Energy Labelling Directives for the former, and CO_2 emission standards and labelling requirements for the latter. For both sectors, one instrument 'pushes' the market to efficiency using minimum standards; the other 'pulls' it towards higher efficiency using labelling and information provision. The EPBD performs both roles for buildings, through different provisions.

- **Promotion of Renewable Sources of Energy** – The RED and EU-ETS are the key instruments in this landscape. Whilst they are generally mutually supportive in achieving the deployment of renewables, their interaction is cost-inefficient regarding centralised electricity production in particular. The interaction does not necessarily induce emission mitigation in the EU-ETS sector, as allowances are able to shift to other Member States and non-electricity production sectors. The RED also encourages distributed energy

generation, supported by the EPBD, and renewable transport, supported effectively by CO_2 emission standards and labelling for passenger cars.

- **Non-CO_2 GHG Emissions** – The ESD is the key instrument in this landscape, supported and implemented by F-Gas Regulations, Landfill Directive, Nitrates Directive, LULUCF Accounting Rules and the EU-ETS for specific GHGs and industrial processes. These instruments are largely neutral in their relationship, as they target specific products, sectors and GHGs with little overlap – with a minor exception of the Nitrates Directive and LULUCF Accounting Rules, concerning N_2O emissions.

Each of the four policy landscapes are relatively well populated. Some contain few but comprehensive pieces of legislation (Carbon Pricing), others contain more targeted, technical instruments (Non-CO_2 GHGs), whilst some contain a mixture (EE&EC and Promotion of Renewables). The instruments discussed are highly varied in their design, approach and target group, and are borne out of a variety of and trade-offs between political, legal and administrative factors.

Such trade-offs have led to some overlap in regulation and incentives, some of which work in mutual support, and others that work against each other. This produces some static and dynamic inefficiency, often due to the multitude of specific objectives (not always emission mitigation or even environmental objectives), and the pursuit of political acceptance and administrative and legal feasibility (e.g. differentiated national targets and obligations). Despite this, the evidence suggests that innovation and emission reductions have occurred as a result of individual instruments, although attributing the contribution of individual instruments is a difficult task, and other factors undoubtedly have a significant impact on emission trends. A number of instruments (including such recasts), are very recent, and have yet to exercise their influence (e.g. EED), whilst others have produced clearly positive results (e.g. Ecodesign Directive), and yet others appear to have had a negligible effect (e.g. CO_2 labeling for passenger cars). The overall instrument mix is relatively flexible (although this varies significantly between instruments), with policy learning in evidence through Directive recasts and other instrument adjustments over time.

In summary, whilst the current instrument mix is not ‘optimal’ and has significant room for improvement in its design, it has been relatively successful in pursuing the overarching objective of GHG emission reduction over time. It is likely that the target of a 20% reduction in emissions from 1990 levels will be achieved, however it is agreed that many changes and additions to the current instrument mix design and ambition will be required to meet an ambitious 2050 target of an 80% reduction below 1990 levels (European Environment Agency, 2012), especially in an ‘optimal’ manner.

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Annex I: Table for the description of instruments

	EU-ETS	Energy Taxation Directive	Effort Sharing Decision	Energy Efficiency Directive
Instrument category	ETS	Tax	ETS (limited)	Command & Control
Instrument subcategory	Cap-and-Trade	Tax on Input/Output to a Production Process	Cap-and-Trade (limited)	Performance Standard
Level of governance	EU	MS	EU/MS	EU/MS
Degree of bindingness	Mandatory	Mandatory	Mandatory	Mandatory
Objectives				
Goal(s)	Greenhouse gas mitigation in a cost-effective manner; Meeting Kyoto Protocol targets, avoid distortions of competition in internal market, promote energy efficient technologies, minimize negative impacts on competitiveness of firms	Reduce distortions of competition that existed between Member States as a result of divergent rates of tax on energy products; Reduce distortions of competition between mineral oils and other energy products that had not been subject to Community tax legislation previously: Increase incentives to use energy more efficiently (to reduce dependency on imported energy and to cut carbon dioxide emissions); Allow Member States to offer companies tax incentives in return for specific undertakings to reduce emissions.	Obliges economic sectors not bound by existing emission reduction obligations (i.e. EU-ETS), to be so. A secondary objective is the promotion of energy security	Make the end-use of energy more economical and efficient by establishing indicative targets and incentives for efficiency, establishing the institutional, financial and legal frameworks needed to eliminate market barriers and imperfections that prevent the efficient end-use of energy, and by creating the conditions for the development and promotion of a market for energy services and for the delivery of energy saving programmes and other measures

Type of target	Cap on total emissions per installation	N/A	Cap on total non-ETS emissions	Indicative primary/final energy use targets in 2020
GHG Scope				
GHGs covered	Carbon dioxide, per fluorocarbons, nitrous oxide	Carbon dioxide (indirectly)	Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons sulphur hexafluoride	Carbon dioxide (indirectly)
Direct/indirect emissions	Direct	Direct & Indirect	Direct & Indirect	Direct & Indirect
Primary/final energy	Primary	Primary and Final	Primary & Final	Primary & Final
Opt-in/opt-out	MS can opt-in GHGs subject to conditions	N/A	N/A	N/A
Sectoral scope				
Sectors of economy	Energy supply, industrial, transport (aviation)	Economy wide, except electricity production	All non-ETS (except LULUCF & int. shipping)	Energy generators, suppliers & consumers
Covered entities	Installations	N/A	N/A	Economy-wide
Covered sites	All energy producers and energy-intensive sectors as defined in EU ETS. In the EU more than 11,500 installations are covered.	All energy consumers	N/A	N/A
Capacity thresholds entities/sites	Combustion installations with rated thermal input above 20MW, specific thresholds for each sector	N/A	N/A	N/A
Opt-in/opt-out for sectors	MS can opt-in entire sectors subject to conditions	Sectors can be opted-out. Electricity production is exempt	N/A	MS can opt out measures under cost-efficiency clauses
Opt-in/opt-out for entities	MS can exclude small installations (emissions below 25000 tones CO2eq or thermal input below 35 MW) subject to conditions	N/A	N/A	
Opt-in/opt-out for sites	N/A	N/A	N/A	

Implementation network				
Competent bodies for adopting instrument	EU institutions, national ministries and other national authorities	DG Taxation & Customers, national financial & taxation authorities	DG CLIMA & National Authorities	DG Energy & National Authorities
Competent body for setting-up instrument	National authorities	National authorities	DG CLIMA & National authorities	DG Energy & National Authorities
Competent body to administer instrument	Commission (through comitology procedures) National authorities	National authorities	DG CLIMA & National authorities	National Authorities
Competent body for registration of participating entities	National authorities, EU Commission	N/A	N/A	National Authorities
Competent body for Monitoring & verifying compliance	National authorities, following EU law, EU Commission competent to draft the regulation on M&R	National authorities	DG CLIMA	DG Energy & National Authorities
Competent body for enforcement of compliance	National authorities, EU Commission (in relation to MS)	National authorities	DG CLIMA	DG Energy & National Authorities
Rules & influencing mechanisms				
Market arrangements				
Non-obligatory for eligible parties	None	N/A	N/A	N/A
Number of participants	> 11,000 installations	N/A	N/A	N/A
Market flexibility				
Trading participants	Not limited	N/A	MS Governments	N/A
Unit type and name	Allowance, Aviation Allowance	N/A	Annual Emission Allowance (AEA)	N/A
Nature of unit	1 Ton CO2eq	N/A	1 Ton CO2eq	N/A
Lifetime of unit	8 years, but can be replaced	N/A	Max 7 years (until 2020)	N/A

	by new ones (Art. 13)			
Banking provisions	Allowed between years in each period and between periods	N/A	Unlimited	N/A
Borrowing provisions	Allowing between years of each period	N/A	Up to 5% subsequent annual AEA allocation	N/A
Financing				
Cost-recovery	Possible via price increases of electricity or products	Reduction in labour taxes encouraged	N/A	N/A
Revenues raised	Increasingly substantial through auctioning, particularly from 2013 onwards	Variable at MS level	N/A	N/A
Eligible technologies	Scope defined in terms of industrial activities rather than technologies	N/A	N/A	N/A
Technological parameters				
Opt-in/opt-out	None provided	N/A	N/A	N/A
Treatment of additionality	Not relevant	N/A	N/A	N/A
Timing				N/A
Operational?	Yes	Yes	Yes	Yes
Operational changes foreseen?	Possible Increase of ambition in cap, possible introduction of carbon price floor, possible withdrawal of allowances by Commission/MS, introducing more sectors and gases, further limits in access to international credits	Proposal to reframe in terms of embodied carbon – but proposal has stalled.	No	No

Compliance period(s)	2005-2007, 2008-2012, 2013-2020, 2020-2028?	N/A	Annual from 2013 to 2020	2013 to 2020
Future continuation	Yes	Yes	No	Unsure
Compliance				
Monetary penalties	Yes, EUR100 per ton CO2eq emitted and not covered by an allowance	Yes – MS Rules	No	MS Rules
Naming and shaming	Yes (Art.16.2)	MS Rules	Yes	MS Rules
Administrative liability	Yes (Art.16) (penalties should be effective, proportionate, and dissuasive)		A deduction of the Member State's AEA allocation for the following year shall apply, equal to the volume excess emissions (in tCO_2e), multiplied by an abatement factor of 1.08.	No
Civil liability				

	Energy Performance of Buildings Directive	**Ecodesign Directive**	**Energy Labelling Directive**	**Emission Standards for Passenger Cars**
Instrument category	Command & Control	Command & Control	Information & Voluntary	Command & Control
Instrument subcategory	Building Codes and Standards	Performance Standards	Environmental Labelling Programme	Performance Standards
Level of governance	MS	EU	EU	EU
Degree of bindingness	Mandatory	Mandatory	Mandatory	Mandatory
Objectives				
Goal(s)	Exploit the potential for cost-effective energy savings in buildings	Ensure the effective functioning of the internal market by requiring products to reach an adequate level of environmental performance, and do not constitute a barrier to intra-EU trade. Increasing energy efficiency, environmental	Harmonising national measures on the publication of information on the energy consumption (and other resources) of household appliances, particularly by means of energy labelling	Set CO_2 emission performance standards for new passenger cars registered in the EU, in order to contribute to the EU's international and self-imposed emission reduction commitments

		protection and energy security are secondary objectives.		
Type of target	N/A	Energy intensity	N/A	Average CO_2 intensity
GHG Scope				
GHGs covered	Carbon dioxide	Carbon dioxide	Carbon dioxide	Carbon dioxide
Direct/indirect emissions	Direct & Indirect	Direct & indirect	Direct & indirect	Direct
Primary/final energy	Primary & Final	Primary & final	Primary & final	Final
Opt-in/opt-out	N/A	N/A	N/A	N/A
Sectoral scope				
Sectors of economy	Buildings	Cross-sectoral	Cross-sectoral	Transport
Covered entities	N/A	N/A	N/A	Passenger cars
Covered sites	Buildings	N/A	N/A	N/A
Capacity thresholds entities/sites	N/A	N/A	N/A	Manufacturers with over 10,000 sales/year
Opt-in/opt-out for sectors	N/A	N/A	N/A	N/A
Opt-in/opt-out for entities	N/A	N/A	N/A	N/A
Opt-in/opt-out for sites	N/A	N/A	N/A	N/A
Implementation network				
Competent bodies for adopting instrument	National Authorities	DG Enterprise & Industry, National Authorities	DG Enterprise & Industry, National Authorities	DG CLIMA & National Authorities
Competent body for setting-up instrument	National Authorities	DG Enterprise & Industry	DG Enterprise & Industry	DG CLIMA & National Authorities
Competent body to administer instrument	National Authorities	DG Enterprise & Industry, National Authorities	DG Enterprise & Industry, National Authorities	DG CLIMA & National Authorities
Competent body for registration of participating entities	N/A	DG Enterprise & Industry, National Authorities	DG Enterprise & Industry, National Authorities	DG CLIMA & National Authorities
Competent body for Monitoring & verifying compliance	National Authorities	DG Enterprise & Industry, National Authorities	DG Enterprise & Industry, National Authorities	Member States
Competent body for enforcement of compliance	National Authorities	DG Enterprise & Industry, National Authorities	DG Enterprise & Industry, National Authorities	DG CLIMA & National Authorities

Rules & influencing mechanisms				
Market arrangements				
Non-obligatory for eligible parties	N/A	N/A	N/A	N/A
Number of participants	N/A	N/A	N/A	
Market flexibility				
Trading participants	N/A	N/A	N/A	N/A
Unit type and name	N/A	N/A	N/A	N/A
Nature of unit	N/A	N/A	N/A	N/A
Lifetime of unit	N/A	N/A	N/A	N/A
Banking provisions	N/A	N/A	N/A	N/A
Borrowing provisions	N/A	N/A	N/A	N/A
Financing				
Cost-recovery	N/A	N/A	N/A	N/A
Revenues raised	N/A	N/A	N/A	N/A
Eligible technologies	N/A	Defined by implementing measures	Defined by implementing measures	Certified 'Eco-innovations'
Technological parameters				
Opt-in/opt-out	N/A	N/A	N/A	N/A
Treatment of additionality	N/A	N/A	N/A	N/A
Timing				
Operational?	Yes	Yes	Yes	Yes
Operational changes foreseen?	No	No	Possibly	Yes – 2020 target
Compliance period(s)	For certain provisions	No	No	Annual
Future continuation	Yes	Yes	Yes	Possibly extended from 2020

Compliance				
Monetary penalties	MS Rules	Yes	Yes	€5 for the first gCO_2/km over the limit, €15 for the second, €25 for the third and €95 for each gCO_2/km above this, for each vehicle registered
Naming and shaming	MS Rules	Yes	Yes	Yes
Administrative liability				
Civil liability				

	CO_2 Labelling for Passenger Cars	**Renewable Energy Directive**	**CCS Directive**	**F-Gas Regulations**
Instrument category	Information & Voluntary	Active Technology Support	Command & Control	Command & Control
Instrument subcategory	Environmental Labelling Programme	Renewable Portfolio Standard	Prohibition or mandating of certain products or practices	Prohibition or mandating of certain products or practices
Level of governance	EU	MS	MS	MS
Degree of bindingness	Mandatory	Mandatory	Mandatory	Mandatory
Objectives				
Goal(s)	Ensure that information relating to the fuel economy and CO_2 emissions of new passenger cars offered for sale or lease in the EU is made available to consumers to enable them to make an informed choice, and thus encourage manufacturers to take steps to reduce fuel consumption of the cars they produce	Raising the share of EU final energy consumption produced from renewable resources to 20%	Establishes a legal framework for the environmentally safe geological storage of CO_2 captured by CCS technology, in such a way to prevent negative impacts to the environmental and human health	Contain, prevent and reduce emissions of f-gases listed in Annex A of the Kyoto Protocol.
Type of target	N/A	Member-State level renewable portfolio standard	N/A	N/A
GHG Scope				
GHGs covered	Carbon dioxide	Carbon dioxide	Carbon dioxide	f-gases
Direct/indirect emissions	Direct	Direct & indirect	Direct	Direct
Primary/final energy	Final	Primary & final	N/A	N/A

Opt-in/opt-out	N/A	N/A	N/A	N/A
Sectoral scope				
Sectors of economy	Transport	Energy	Energy & Industrial	Industrial
Covered entities	Passenger cars	Cross-Sectoral	N/A	N/A
Covered sites	N/A	N/A	CO_2 storage sites	N/A
Capacity thresholds entities/sites	N/A	N/A	N/A	N/A
Opt-in/opt-out for sectors	N/A	N/A	N/A	N/A
Opt-in/opt-out for entities	N/A	N/A	N/A	N/A
Opt-in/opt-out for sites	N/A	N/A	N/A	N/A
Implementation network				
Competent bodies for adopting instrument	DG CLIMA & National Authorities	DG Energy & National Authorities	National Authorities	National Authorities
Competent body for setting-up instrument	DG CLIMA & National Authorities	DG Energy & National Authorities	National Authorities	National Authorities
Competent body to administer instrument	DG CLIMA & National Authorities	DG Energy & National Authorities	National Authorities	National Authorities
Competent body for registration of participating entities	DG CLIMA & National Authorities	DG Energy & National Authorities	National Authorities	National Authorities
Competent body for Monitoring & verifying compliance	Member States	DG Energy & National Authorities	National Authorities	National Authorities
Competent body for enforcement of compliance	DG CLIMA & National Authorities	DG Energy & National Authorities	National Authorities	National Authorities
Rules & influencing mechanisms				
Market arrangements				
Non-obligatory for eligible parties	N/A	N/A	N/A	N/A
Number of participants	N/A	EU28	N/A	N/A

Market flexibility				
Trading participants	N/A	N/A	N/A	N/A
Unit type and name	N/A	N/A	N/A	N/A
Nature of unit	N/A	N/A	N/A	N/A
Lifetime of unit	N/A	N/A	N/A	N/A
Banking provisions	N/A	N/A	N/A	N/A
Borrowing provisions	N/A	N/A	N/A	N/A
Financing				
Cost-recovery	N/A	MS Level differences	N/A	N/A
Revenues raised	N/A	MS Level differences	N/A	N/A
Eligible technologies	N/A	Wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases	N/A	Refrigeration, air conditioning, heat pumps and fire protection systems
Technological parameters				
Opt-in/opt-out	N/A	N/A	N/A	N/A
Treatment of additionality	N/A	N/A	N/A	N/A
Timing				
Operational?	Yes	Yes	Yes	Yes
Operational changes foreseen?	Yes – proposed amendment with various provisions	No	No	Yes – various proposals including cap-and-trade mechanism with tightened cap
Compliance period(s)	N/A	2008-2020	N/A	N/A
Future continuation	Yes	Possibly	Yes	Yes
Compliance				
Monetary penalties		Not at MS level	Yes	MS Level

Naming and shaming			Yes	MS Level
Administrative liability			Yes	MS Level
Civil liability			Yes	MS Level

	Landfill Directive	**Nitrates Directive**	**LULUCF Accounting Rules**	
Instrument category	Command & Control	Command & Control	Stand-Alone Reporting Requirements	
Instrument subcategory	Prohibition or mandating of certain products or practices/Performance Standards	Framework Standards	N/A	
Level of governance	MS	MS	EU/MS	
Degree of bindingness	Mandatory	Mandatory	Mandatory	
Objectives				
Goal(s)	Prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill	Protect water quality by preventing surface and groundwater pollution caused or induced by nitrates from agricultural sources through the promotion of good farming practices	Establish robust common accounting, monitoring and reporting rules for LULUCF in the EU, in the form of a dedicated legal framework, in line with international agreement	
Type of target	Reduction of emissions from biodegradable waste	N/A	N/A	
GHG Scope				
GHGs covered	Methane	Nitrous oxide	Carbon dioxide, methane, nitrous oxide	
Direct/indirect emissions	Direct	Indirect	Direct	
Primary/final energy	N/A	N/A	N/A	

Opt-in/opt-out	N/A	N/A	N/A	
Sectoral scope				
Sectors of economy	Waste	Agriculture	Agriculture (primarily)	
Covered entities	Landfill operators	N/A	N/A	
Covered sites	Landfills	Farms	Areas undergoing afforestation, reforestation (on lands not forested on 1st January 1990), deforestation, forest management, cropland management and grazing land management	
Capacity thresholds entities/sites	N/A	N/A	N/A	
Opt-in/opt-out for sectors	N/A	N/A	N/A	
Opt-in/opt-out for entities	N/A	N/A	N/A	
Opt-in/opt-out for sites	N/A	N/A	N/A	
Implementation network				
Competent bodies for adopting instrument	National Authorities	National Authorities	National Authorities	
Competent body for setting-up instrument	National Authorities	National Authorities	National Authorities	
Competent body to administer instrument	National Authorities	National Authorities	National Authorities	
Competent body for registration of participating entities	National Authorities	National Authorities	National Authorities	
Competent body for Monitoring & verifying compliance	National Authorities	National Authorities	National Authorities	
Competent body for enforcement of compliance	National Authorities	National Authorities	National Authorities	
Rules & influencing mechanisms				

Market arrangements				
Non-obligatory for eligible parties	N/A	N/A	N/A	
Number of participants	N/A	N/A	EU28	
Market flexibility				
Trading participants	N/A	N/A	N/A	
Unit type and name	N/A	N/A	N/A	
Nature of unit	N/A	N/A	N/A	
Lifetime of unit	N/A	N/A	N/A	
Banking provisions	N/A	N/A	N/A	
Borrowing provisions	N/A	N/A	N/A	
Financing				
Cost-recovery	N/A	N/A	N/A	
Revenues raised	MS dependent	N/A	N/A	
Eligible technologies	N/A	N/A	N/A	
Technological parameters				
Opt-in/opt-out	N/A	N/A	N/A	
Treatment of additionality	N/A		N/A	
Timing		N/A		
Operational?	Yes	Yes	Yes	
Operational changes foreseen?	No	No	No	
Compliance period(s)	2006, 2009 and 2016 for biodegradable waste targets	N/A	2013-2020	
Future continuation	Yes	Yes	Probable	
Compliance				
Monetary penalties	MS Dependent	MS Dependent		
Naming and shaming	MS Dependent	MS Dependent		

Administrative liability	MS Dependent	MS Dependent		
Civil liability	MS Dependent	MS Dependent		

Annex II: Types of interactions between instruments

EU-ETS – Energy Taxation Directive

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	Different	EU-ETS is a cap-and-trade system, whilst the ETD is a direct tax on energy products
Degree of bindingness	m-m	Both mandatory on their target groups
Objectives	p-s	The EU-ETS explicity aims to reduce GHG emissions, whilst the primary focus of the ETD is the proper functioning of the internal market
Scope	p-pa	EU-ETS obligates the power sector and various energy-intensive industries. Energy products used for power production are exempt from the ETD
Implementation network	d-r	
Rules and influencing mechanisms	Regulatory	

EU-ETS – Effort Sharing Decision

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	Identical (to an extent)	Both place emission caps on different economic sectors. ESD had banking/borrowing provisions, and limited trading is allowed.
Degree of bindingness	m-m	

Objectives	p-p	
Scope	i-i	Explicitly designed to cover different sectors of the economy
Implementation network	d-r	
Rules and influencing mechanisms	Trading	

EU-ETS – Renewable Energy Directive

Table 2: types of interaction between instruments	Type of policy interaction	Description
Area of policy interaction		
Instrument type	Different	ETS and renewable portfolio standard
Degree of bindingness	m-m	
Objectives	p-s	Primary objective of the RED is the promotion of renewables
Scope	p-pa	RED is economy-wide
Implementation network	d-r	
Rules and influencing mechanisms	Trading/Regulatory	

Ecodesign Directive – Energy Labelling Directive

Table 2: types of interaction between instruments	Type of policy interaction	Description
Area of policy interaction		
Instrument type	Different	Performance standard and environmental labelling programme
Degree of bindingness	m-m	

Objectives	s-s	
Scope	Os-pa	Both instruments work in concert on target products
Implementation network	d-r	
Rules and influencing mechanisms	Regulatory	

Emission Standards for Passenger Cars – CO2 Labelling for Passenger Cars

Table 2: types of interaction between instruments	Type of policy interaction	Description
Area of policy interaction		
Instrument type	Different	Performance standard and environmental labelling programme
Degree of bindingness	m-m	
Objectives	p-p	Both aim directly at reducing CO_2 emissions from cars
Scope	Os-pa	
Implementation network	d-r	
Rules and influencing mechanisms	Regulatory	