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Review of literature on EU ETS Performance

A literature review and gap analysis of policy evaluations

Öko-Institut Working Paper 2/2015

Sean Healy
Katja Schumacher
Anamaria Stroia
Stephan Slingerland

Öko-Institut e.V. / Oeko-Institut e.V.

Geschäftsstelle Freiburg / Freiburg Head Office
Postfach / P.O. Box 17 71
79017 Freiburg. Deutschland / Germany
Tel.: +49 761 45295-0
Fax: +49 761 45295-288

Büro Darmstadt / Darmstadt Office
Rheinstraße 95
64295 Darmstadt. Deutschland / Germany
Tel.: +49 6151 8191-0
Fax: +49 6151 8191-133

Büro Berlin / Berlin Office
Schicklerstraße 5-7
10179 Berlin. Deutschland / Germany
Tel.: +49 30 405085-0
Fax: +49 30 405085-388

info@oeko.de
www.oeko.de

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Sean Healy (Öko-Institut)

Katja Schumacher (Öko-Institut)

Anamaria Stroia (REC)

Stephan Slingerland (Triple E)

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Executive Summary

The EU ETS has been subject to increasing levels of scrutiny as the policy instrument has been considered to have underperformed in recent times, also as a consequence of external shocks (i.e. economic recession). Although the European Council Conclusions reaffirmed in October 2014 that the EU ETS will remain the main instrument for GHG abatement, reform will be necessary to ensure that the EU ETS functions correctly in the future and delivers a GHG reduction of 43% below 2005 levels as outlined in the 2030 Framework. As the scheme enters a critical phase in its development, the Öko-Institut, Triple E & REC have been commissioned by the EEA to 1) perform a review of evaluations on the EU ETS and 2) to identify gaps that could be addressed in future research.

Literature Review

The first part of the study focused on reviewing the existing literature, which evaluates the performance of the EU ETS. The literature has been reviewed in accordance with five evaluation criteria (effectiveness, efficiency, coherence, EU added value and relevance) all of which were associated with specific questions to ensure that the review remained focused in responding to the most important issues. The study answered each of these questions following an extensive search of the literature, which reviewed over 250 evaluations from a range of different sources (i.e. internet search engine results, academic papers, governmental publications) adopting a systematic approach in order to limit bias. The main findings from the literature review are summarised in the following for each of the review questions:

To what extent has the EU ETS driven GHG abatement in the short and long term?

GHG abatement

There is a general consensus within the literature reviewed that the EU ETS has driven GHG abatement. However, the difficulties of establishing a business as usual (BAU) baseline to estimate abatement (defined as the difference between verified emissions and business as usual) lead to outcomes with greater levels of uncertainty.

To what extent has the EU ETS promoted low-carbon investments and supported the competitiveness of European firms in the short and longer term?

Investments

There is a consensus within the literature reviewed that the EU ETS is unable to deliver both low cost GHG reductions and promote low-carbon technology as the objectives conflict with one another. Uncertain and currently low EUA prices have failed to promote low-carbon technologies and complementary policies may be necessary to improve the dynamic efficiency of the EU ETS.

Carbon leakage and competitiveness

The consensus from the literature reviewed is that no leakage has occurred yet, which shows a difference between ex-ante expectations and ex-post empirical analysis. No detrimental impact on competitiveness has been observed. This may be due to economic shocks and carbon leakage provisions. There is a high level of uncertainty on the potential extent of (future) investment leakage.

How efficient is the implementation of the EU ETS in both the short and longer term?

Price signal

If the price signal is determined by market fundamentals this implies that the carbon price reflects marginal abatement costs and therefore the market functions efficiently. Studies show ambiguous results, however most support the hypothesis that price is driven by market fundamentals.

Transaction costs

The literature reviewed suggests that transaction costs are higher in a cap and trade scheme than in a carbon tax. Transaction costs were reasonably low for the larger emitters, however transaction costs were comparably high for smaller emitters.

To what extent has the allocation method of distributing allowances affected the efficient functioning of the EU ETS?

Cost pass through

There is a general consensus in the literature reviewed that in the energy sector there has been a substantial pass through of carbon costs and windfall profits. There is evidence emerging that the energy intensive sector has also benefited from free allocation in Phase I and II of the EU ETS.

Windfall profits

Evidence in the literature reviewed shows that In Phase I and II of the EU ETS windfall profits were high especially for electricity producers, transferring billions of euros from consumers to shareholders.

How well does the EU ETS complement other EU climate and energy policies?

Coherence

There is a general consensus within the literature reviewed that the impact of other policies such as the Renewable Energy (RES) and Energy Efficiency (EE) Directives have mitigated the price signal of the EU ETS. However, it is important to acknowledge that the explicit objective for the EU ETS to incentivise low-carbon investment was set after the RES and EE Directives were adopted.

To what extent has the implementation of the EU ETS by Member States been improved by the adoption of more harmonised approaches?

Harmonisation and market oversight

Harmonised approaches have generally improved the implementation of the EU ETS by removing the previous distortions caused by Member States interpreting rules differently.

Would alternative policy instruments at EU or national levels have been more cost effective than the EU ETS?

Alternative policies

The main focus of the evaluations reviewed is on the added value of EU intervention with scenarios developed to assess the impact of alternative policies such as carbon taxes and emission performance standards or simply no policies at all. The majority of the studies evaluated show that emission reductions are achieved at lower cost by emissions trading than by alternative policies.

How well do the objectives of the EU ETS correspond to the needs within the EU?

Relevance of the EU ETS objectives

The objectives of the EU ETS do correspond to needs within the EU, however there is currently a debate within the literature reviewed about whether complementary instruments are necessary to support the EU ETS in order to fulfil the needs of the EU.

Gap Analysis

The second part of the study focused on identifying gaps in the literature evaluating the EU ETS. In order to determine which aspects of the review questions require further research in the literature, a matrix table was developed, which enabled the review team to categorise evaluations according to 1) the sectoral and geographical scope 2) the content of the evaluation and 3) the methodology applied. Evaluations were often applicable to more than one broad category and evaluation criteria sub-field, therefore the review team were instructed to categorise evaluations to broad categories and evaluation criteria only if the outcome of the primary research was directly applicable. Following the categorisation of the evaluations, gaps in the literature were identified based upon the following set of criteria:

- The conclusions of policy evaluations for a broad category and evaluation criteria sub-field were inconclusive referring to the literature review in the previous section;
- The range of policy evaluation methods applied for a particular broad category and evaluation sub-field may not be sufficiently varied or data availability was poor;
- The number of policy evaluations for a broad category and evaluation criteria sub-field was below a relative threshold (i.e. below the average);

The outcome of the gap analysis is presented in the table below which illustrates the availability of evaluations on the performance of the EU ETS from the literature reviewed in this study.

Broad Categories	Objectives				Interaction				Governance				Functioning				Short term				Long term			
Sectoral Scope	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other
Geographical Scope																								
EU	2				18	6	1	2	25	3	1	1	86	32	18	6	34	20	39	1	21	16	27	2
Non-EU													2				1				1			
Evaluation Criteria																								
Relevance																								
Objectives vs needs	2																1				1			
Other													1											
Effectiveness																								
GHG abatement					4			1	4			1	13	2		1	18	5	1		6	1		1
Investment / innovation					2	2			4	2	1		6	4	2		9	9	8		12	13	10	
Competitiveness					1				2	1	1		4	3	3	1	8	7	23	1	7	5	15	1
Carbon leakage					1				3	1	1		8	1	4		10	2	23		6	1	16	
Other																								
Efficiency																								
Flexible mechanisms					4	1	1	1	5				19	2	3	2	7				3			
Transaction / admin costs					1				2				11		1		1				2			
Cap setting					2				4				11	1	2		6	1	1		1	1	2	
Allocation of allowances					3				8	1			33	10	8		15	5	4		5	3	3	
MRV									4				4		2		1				1			
Price signal					4	3	1	1	4				30	11	1	1	3	3			2	3		
Cost-pass through													3	15	7	2	1	1	3	1			1	1
Windfall profits					1				1				2	10	3	1	2		1		1			
Structual reform					1			1	4	1		1	18	1		2	6			1	2			2
Other									1				2		1									
EU Added Value																								
Alternative policies					5	1		1	8	2	1	1	3			1	2				5	2	1	1
Harmonisation									9				6				1							
Market oversight									3				2											
Other					1				9				4								1			
Coherence																								
Internal coherence					3				1				1											
External coherence					17	6	1	2	6	1		1	6	3	1	2	3			0	3	2		1
Other																								
Methodology																								
Theory based evaluation	1				3	1	1	1	4				7	4	1	1	2				2			
Econometric /statistical analysis					2				3	1	1		33	20	8		10	6	12		6	3	4	
Top down modelling					1	1	1	2	3			1	1	1	1	2	4	1	4		3	1	4	1
Bottom up modelling					7				5	2			8	10	2		3	7	12		2	6	10	
Multi criteria analysis					1				1				3				1				1			
Surveys									2				8		3	1	5		2		6		2	
Data analysis					4	3			7				27	6	3	2	12	5	12		4	4	9	
Interviews									2				2	3	4		1	3	7		2	3	6	
Event study	1																1				1			
Case Studies										1	1		3	1	2			2	1			3	2	
Legal analysis																			1				1	
Other					2	1			2				1		2	1	2		1	1	1			1

Note: Evaluations are categorised under multiple categories and therefore do not add up to the totals for each broad category under the sectoral and geographical scope.

Source: Own calculation

The outcome of the gap analysis identified 14 evaluation gaps (see table below), which were categorised according to one of the following types:

- *Methodological gap*: refers to limitations in the methodology currently deployed in the literature to assess the performance of the EU ETS;
- *Data gap*: refers to the limitation of data that prevents more quantitative approaches to assess the performance of the EU ETS from being implemented and;
- *Coverage gap*: refers to aspects of the EU ETS which are insufficiently covered in the literature reviewed.

Evaluation Gap	**Type of Gap**
(1) Standardised counterfactual baselines need to be developed to evaluate EU ETS performance	Methodological
(2) Incomplete time-series data - research needs to be updated with more complete data	Data
(3) Lack of available data on investments	Data
(4) Limited evaluations on the past and future scope changes to the EU ETS	Coverage
(5) Sensitivity analysis of econometric results on cost pass through necessary	Methodological
(6) Dynamic efficiency of the EU ETS - is the price signal strong enough?	Coverage
(7) Lack of data availablity on transaction costs	Data
(8) Extent to which renewables development is accounted for in the 2030 EU ETS cap	Coverage
(9) Future impact of the Market Stability Reserve on the functioning of the EU ETS	Coverage
(10) Standardised, credible and transparently calculated marginal abatement costs curves	Methodological
(11) Limited evaluations on market oversight	Coverage
(12) Future allocation of free allowances - defining 'appropriate measures'	Coverage
(13) Limited evaluations on alternative policies to EU ETS	Coverage
(14) Limited evaluations assessing the relevance of the objectives to the needs of the EU	Coverage

Source: Own calculation

The study has identified important methodological gaps that exist in the construction of credible baselines from which to assess the impact of the EU ETS on GHG abatement, competitiveness etc. It therefore should be a priority to encourage greater collaboration amongst researchers to ensure that these counterfactual baselines become more standardised and widely agreed upon in the future to enhance the comparability between evaluations. Data gaps identified in the literature will also need to be addressed if important questions concerning the performance of the EU ETS, especially with regards to investment leakage, are to be definitively answered in the future.

Coverage gaps in the literature mainly relate to the emergence of new topics as the EU ETS enters a period of reform. It is evident that further clarity will be required to ascertain whether additional complementary policies (i.e. emission performance standards) are necessary to improve the dynamic efficiency of the scheme and create a strong and stable price signal to promote the low-carbon technologies necessary to deliver the most ambitious emission reductions targeted in 2050. The proposal by the European Commission to introduce greater flexibility in managing the supply of allowances in the EU ETS, should help to alleviate previous problems experienced with economic shocks and overlapping policies. However, this will need to be validated by future research. The extension of carbon leakage provisions beyond 2020 (as announced in the European Council Conclusions in October, 2014) will be another important area of research.

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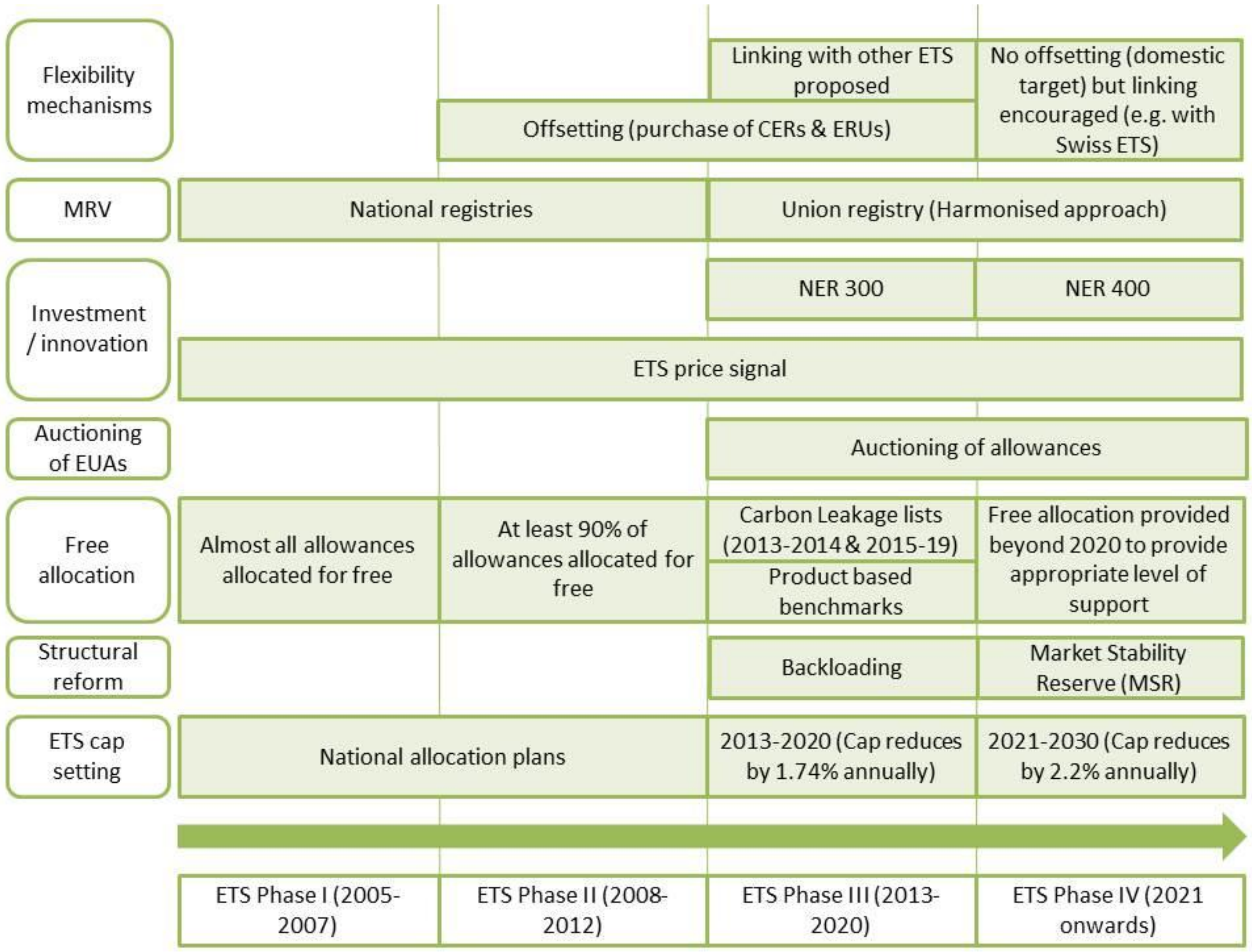
1. Introduction

The 2030 Framework was recently approved by the European Council in October 2014, which sets a domestic greenhouse gas (GHG) reduction target of 40% compared to 1990 levels and also sets a target of at least 27% for renewable energy and energy savings by 2030. The conclusions of the European Council reaffirmed the EU ETS as the main instrument to achieve the domestic GHG reduction target. The conclusions also emphasise that reform is necessary to ensure that the EU ETS functions correctly to deliver the expected 43% reduction below 2005 levels contribution from the EU ETS sector.

The EU ETS has evolved over the three trading phases with improvements in implementation via a move towards the harmonisation of registries, caps and a transition towards increased use of auctioning of allowances (Figure 1). Despite progress it is widely acknowledged that the price signal of the EU ETS has been underperforming in recent years as a consequence of a surplus of allowances. This could have delayed domestic abatement and low-carbon investment decisions. It also may increase overall compliance costs in the long run. The European Commission has therefore proposed several structural reforms to address the underperformance of the EU ETS in Phase IV (Figure 1).

Figure 1 Overview of the evolution of the key design elements of the EU ETS

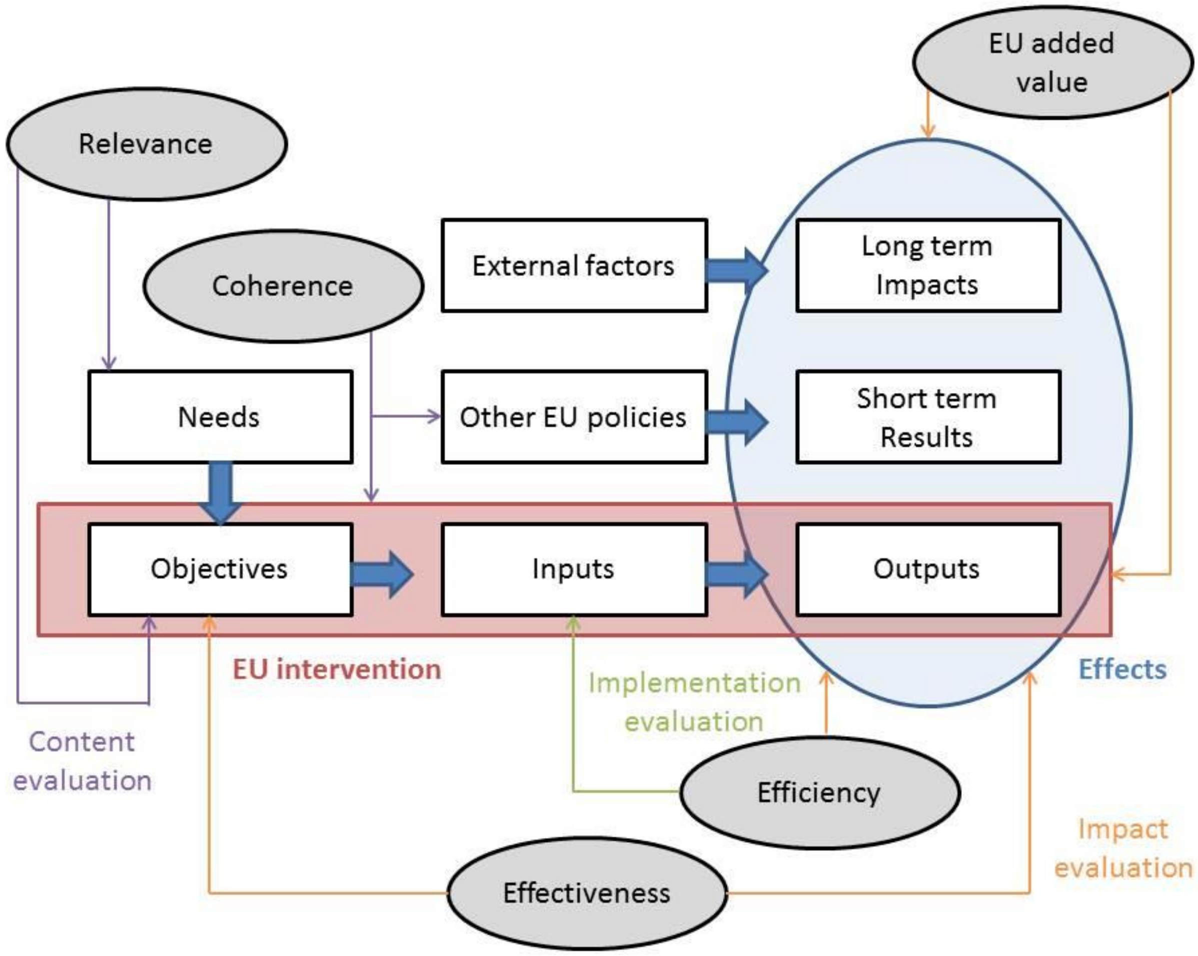


Source: Own illustration

As the scheme enters a critical phase in its development, the Öko-Institut, Triple E & REC have been commissioned by the EEA to perform a review of evaluations on the EU ETS and to identify gaps that could be addressed in future research.

In order to perform a comprehensive review of evaluations on the EU ETS, we have designed a conceptual framework based upon an intervention logic model (Figure 2). The key interventions are confined within the red rectangle in Figure 2, which include inputs required to implement the EU ETS (i.e. compliance costs of firms, administrative costs of governments) to support meeting objectives (that should relate to the needs of the EU) and the desired output of the EU ETS (i.e. establishing a price signal to incentivise abatement at low cost).

Figure 2 Intervention logic model and key evaluation criteria



Source: Adapted from European Commission (2013) and EEA (2001)

The effects of the EU ETS are confined to the blue circle in Figure 2, which can be categorised as short and long term effects that may also be either intended (i.e. abatement, investment ect.) or unintended (i.e. carbon leakage, windfall profits ect.). The effects of the EU ETS can also be influenced by external factors (i.e. shocks to the system such as the economic recession) and the interaction with other energy and climate policies (i.e. the Renewable (RES) and Energy Efficiency (EE) Directives). In order to comprehensively review the literature on the EU ETS (and subsequently identify gaps) we have set review questions to assess for each of the five evaluation criteria[1] recently proposed by the European Commission (2013) for use in evaluations (illustrated by the grey circles in Figure 2)

In advance of the review of the literature on EU ETS evaluations, the next section provides an overview of formally declared policy objectives for the EU ETS, focusing on how they have evolved over time and how they relate to both the key design elements of the EU ETS and the evaluation criteria that have been adopted for this report. The methodology and main findings of the literature review will then be provided in Section 3 and will be subsequently followed by the gap analysis of evaluations on the EU ETS in Section 4 identifying gaps that warrant further research. Concluding remarks to the report will be provided in Section 5.

1 A description of the five evaluation criteria is provided in Section 3.2

2. Objectives of the EU ETS

The starting point for the review of the literature is to fully understand the objectives of the policy intervention. The objectives of the EU ETS as outlined in the ETS Directive include:

- ‘to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner’ (EC, 2009);
- ‘reductions of greenhouse gas emissions to be increased so as to contribute to the levels of reductions that are considered scientifically necessary to avoid dangerous climate change’ (EC, 2009);
- ‘assessing and implementing a stricter Community reduction commitment exceeding 20 %, to be applied upon the approval by the Community of an international agreement on climate change leading to greenhouse gas emission reductions exceeding those required in Article 9, as reflected in the 30 % commitment endorsed by the European Council of March 2007’ (EC, 2009).

It is important to acknowledge that the objectives of the EU ETS have changed over time from using flexibility mechanisms in order to cost effectively fulfil their Kyoto Protocol obligations in 2000 to the recent declaration at the Seventh Environment Action Programme (EAP) in 2013 for the EU ETS to incentivise low-carbon investments and to promote a global carbon market (see below):

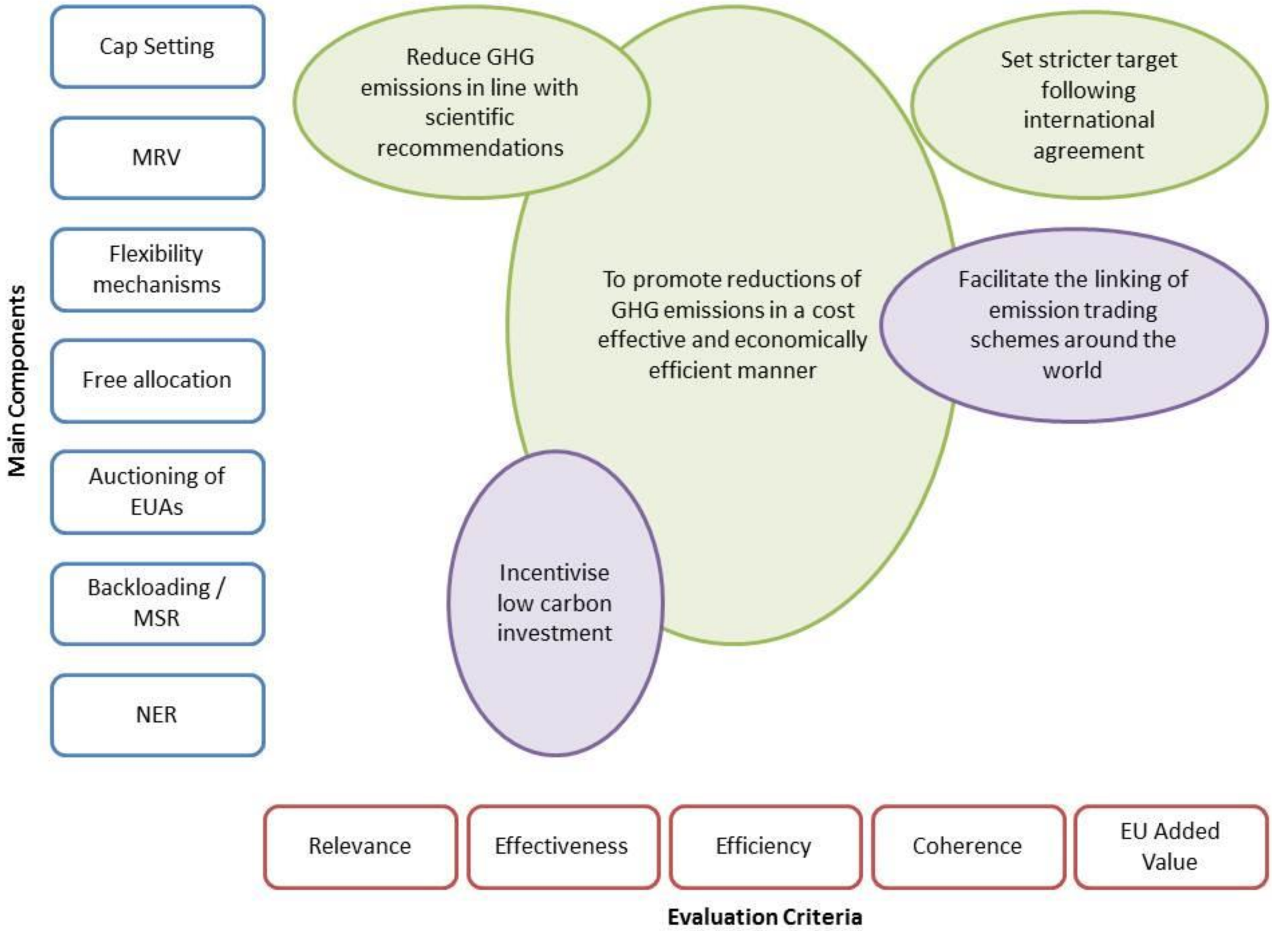
- ‘to enhance the cost effectiveness of the EU’s implementation strategy [of the Kyoto Protocol] including the preparation for the use of the Kyoto Protocol’s flexible mechanisms’ (European Commission, 2000);
- ‘to incentivise low-carbon investment’ (EU, 2013);
- ‘promoting the further development and implementation of emissions trading schemes around the world and facilitating the linking of such systems’ (EU 2013).

The relationships between the policy objectives from the ETS Directive (represented by the green circles) and additional policy objectives (represented by the purple circles) are illustrated in a stylised manner in Figure 3.

The objective of the EU ETS to ‘reduce emissions in line with scientific recommendations’ relates mainly to the relevance evaluation criteria as the objective responds directly to the scientific need to lower levels of GHG emissions. While the objective to set stricter targets in light of an international agreement is more related to the added value of the EU to influence UNFCCC negotiations and set ambitions that are coherent with the actions of other international actors. The objective of the EU ETS to ‘promote reductions of GHG emissions in a cost effective and economically efficient manner’ is more wide ranging and relates to the effectiveness (i.e. evaluating abatement), efficiency (i.e. evaluating implementation) and coherence (i.e. evaluating policy interaction) evaluation criteria.

The additional (formal and informal) objectives overlap, in particular, with the objective to reduce emissions cost effectively and economically efficiently and may therefore complement or potentially conflict with one another. For example, the additional objective to facilitate linking between emission trading schemes may improve efficiency in the long run by lowering compliance costs for firms in the EU ETS (due to lower abatement options available in other international schemes). However, alternatively the additional objective to incentivise low-carbon investment may conflict with the objective of achieving GHG reductions at the lowest cost.

Figure 3 **Relevance of the objectives to the main components of the architecture of the EU ETS and the evaluation criteria**



Source: Own illustration

The achievement of all of the objectives illustrated above depends upon how the main components of the architecture of the EU ETS (i.e. cap setting, MRV, flexibility mechanisms, free allocation, auctioning etc.) have been designed and implemented. For example, the introduction of backloading and the proposal for a Market Stability Reserve both aim to increase the scarcity of allowances in the system in order to further incentivise low-carbon investment by creating a more stable and gradually increasing carbon price. The relationship between the different components of the EU ETS architecture and the achievement of the objectives will be explored further in the literature review (Section 3).

3. Literature Review

The methodological approach of the literature review is briefly summarised in Section 3.1 and is subsequently followed by a discussion of the main findings in Section 3.2 and a brief summary in Section 3.3.

3.1. Methodological approach

Based upon the intervention logic model and evaluation criteria introduced in the introduction, a methodology was developed to review the literature in a systematic manner to ensure that all of the important aspects of EU ETS were captured by the literature search with data collected to provide input to the subsequent gap analysis. The literature review will be briefly explained in the following sub-sections with further information provided in Section 7.

3.1.1. Question setting

A list of questions were developed in order to guide the review of the literature, which were grouped in order to operationalise the criteria suggested by the European Commission for policy evaluation (European Commission, 2013). The list took into account the objectives associated with the EU ETS that were discussed in Section 2. The main findings of the literature review in Section 3.2 were structured in accordance with a response to the following review questions:

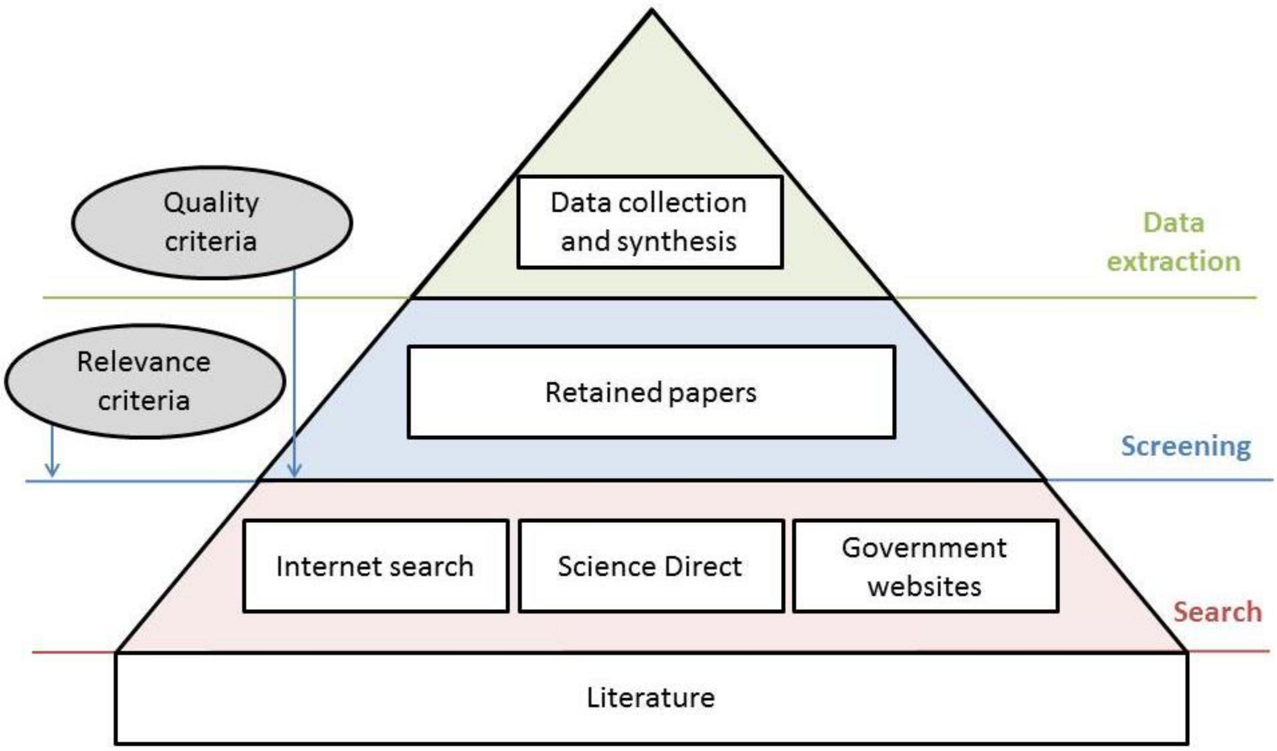
1) Effectiveness
   - To what extent has the EU ETS driven GHG abatement in the short and longer term?
   - To what extent has the EU ETS promoted low-carbon investments and supported the competitiveness of European firms in the short and longer term?
2) Efficiency
   - How efficient is the implementation of the EU ETS in both the short and longer term?
   - To what extent has the allocation method of distributing allowances affected the efficient functioning of the EU ETS?
3) Coherence
   - How well does the EU ETS complement other EU climate and energy policies?
4) EU added value
   - To what extent has the implementation of the EU ETS by Member States been improved by the adoption of more harmonised approaches?
   - Would alternative policy instruments at EU or national levels have been more cost effective than the EU ETS?
5) Relevance
   - How well do the objectives correspond to the needs within the EU?

3.1.2. Literature search, screening and data extraction

The review protocol provided guidance to the review team on how to search, screen and extract information from the literature on the performance of the EU ETS (Figure 4). A range of sources were considered in the literature search in order to limit any bias that may have occurred from an over reliance on one particular source of information. Furthermore the extensive use of search terms ensured that evaluations on all aspects of the EU ETS performance were collected. The search of the literature included the following sources of information:

- **1000** internet search engine results: the top 50 results for each of the 20 search terms (i.e. EU ETS + abatement, EU ETS + investment ect.) entered were evaluated by the review for their relevance to the review questions set;
- Over **250** academic papers: the 20 search terms were entered into the Science Direct search facility and all relevant papers to address the review questions were downloaded for further evaluation by the review team;
- Over **500** links from government (or government affiliated) websites: the multiple languages of the review team were utilised to uncover relevant publications from Member State and international governments that were relevant to the review questions set;
- Supplementary publications were also added by the review team based upon their expertise and searching recent literature reviews and specific website for additional publications to add to the evidence base.

Figure 4 Stages of the review protocol



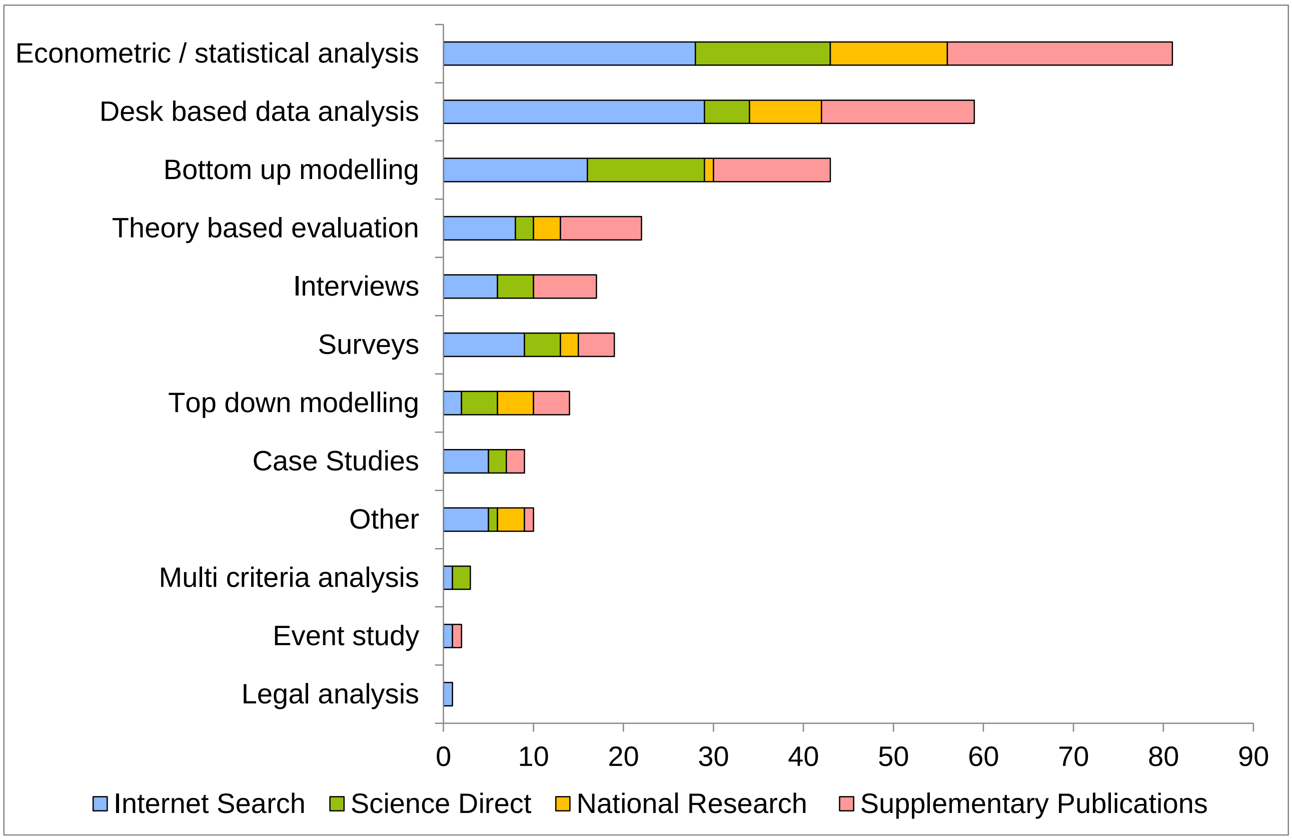
Source: Own illustration

Following the literature search, the resulting papers were screened based upon their quality (i.e. evaluations that were evidence driven with transparent and robust methodologies) and their relevance to respond to one of the five review questions set. As a result of the screening process the number of retained papers decreased to several hundred, which were then evaluated in more detail with data collected and entered into a data entry worksheet (Figure 8) and used in the subsequent gap analysis. Following a more detailed assessment of the papers retained, research themes were identified (i.e. GHG abatement, investment ect.) and the outcomes of evaluations related to each research theme were collated in various assessment tables to provide a snapshot of options from the literature reviewed.

3.2. Main findings

Based upon the methodology outlined in the previous section, several hundred publications were reviewed in detail (Figure 5) with data extracted to contribute towards the gap analysis. With secondary publications excluded from the analysis (i.e. literature reviews, briefings etc.) the most frequent evaluations reviewed in the literature involved econometric or other statistical techniques (81 evaluations) followed by more general data analyses (59 evaluations) and bottom up modelling (43 evaluations). The internet search accounted for 40% of the evaluations reviewed followed by supplementary evaluations found based upon expert knowledge (30%), science direct search of academic papers (19%) and the remaining evaluations were provided by national governments or affiliated research institutes.

Figure 5 Evaluations reviewed after screening process by methodology



Note: Several evaluations may have adopted more than one methodology

Source: Own illustration

The lower number of evaluations from national governments or affiliated research institutes may be explained by several publications already being identified through alternative searches. However a general conclusion from the review team (after comprehensively searching on government websites utilising a range of languages) is that the availability of evaluations on the EU ETS from Member States could be improved upon.

Following the detailed review of the retained papers from the screening process, evaluation outcomes were collated for a number of research themes. The main findings from the systematic review of the literature will be presented in the following sections and structured in accordance with the five review questions outlined in the previous section, which relate to the criteria adopted by the European Commission in their policy evaluations.

3.2.1. Effectiveness

Effectiveness refers to the extent to which the intervention caused the observed effects and whether or not these effects correspond to the objectives of the intervention (European Commission, 2013). For the EU ETS the intended impacts of the policy intervention, such as cost effective GHG reductions (objective set in the ETS Directive) and encouraging investments in low-carbon technology (objective set in the 7th EAP), will need to be evaluated against any unintended effects of the policy that may have developed over time. This section of the literature review responds to the following set of questions:

To what extent has the EU ETS driven GHG abatement in the short and long term?

GHG abatement

There is a general consensus within the literature reviewed that the EU ETS has driven GHG abatement (Table 1). However, the difficulties of establishing a business as usual (BAU) baseline to estimate abatement (defined as the difference between verified emissions and business as usual) lead to outcomes with greater levels of uncertainty.

Estimation of GHG abatement depends upon a comparison between observed emission levels and emission levels calculated based upon a BAU baseline without the EU ETS. Ellerman & Buchner (2006) estimate abatement in Phase I based on historic emissions data (derived from National Allocation Plans (NAPs)) and indicators of economic activity, energy and carbon intensity trends. In comparison to their BAU baseline. Ellerman & Buchner (2006) suggest that the level of GHG abatement that is attributable to the EU ETS ranges from between 2.5% and 5% in both 2005 and 2006. In a subsequent ex-post analysis, Anderson & Di Maria (2010) suggest that there was an incentive for Member States in Phase I to attempt to influence allocation by reporting inflated historical emissions. Indeed they show that if the ex-ante BAU emissions from NAPs were deemed to be correct, the EU-25 would have experienced a net GHG abatement of 12.7% compared to the baseline. However, given that Anderson & Di Maria (2010) only estimate a net GHG abatement of 2.8% compared to their own BAU baseline (estimated using an econometric model and data primarily from Eurostat) – they conclude that the ex-ante projections of Phase I BAU emissions were of questionable quality.

Ellerman et al. (2014) argue that despite the difficulty in setting the cap under uncertainty, which was made even more difficult by time constraints and poor data quality, the over allocation of allowances in Phase I was still reasonably small (equivalent to only 1.3% of the total EU ETS emissions between 2005 and 2007[2]). They emphasise that the abatement that occurred as a result of the strong price signal in the first twenty months of Phase I could not be 'taken back' following the collapse of the EUA price towards the end of the trading period when it was likely that emissions returned to BAU levels due to the weak price signal.[3]

Despite criticisms in the literature about the causality assumed by the above findings (i.e. any deviation below projected emissions is due to abatement driven only by the EU ETS), there is evidence of abatement opportunities being created in Phase I by the existence of a carbon price. For example, Delarue et al. (2008) empirically assess the occurrence of fuel switching in the power sector during Phase I of the EU ETS. They observed that the share of gas declined by 7.7% between 2005 and 2006 and imply that the switch from coal to gas was larger in 2005 due to the higher price of CO_2 influencing decision making. Following empirical observations, Delarue et al. (2008) use a bottom up model to simulate fuel switching with and without observed CO_2 prices and find that GHG emissions in the EU power sector would have been approximately 88 and 59 Mt higher in 2005 and 2006 respectively. Furthermore, McGuinness & Ellerman (2008) provide an econometric analysis of fuel switching in the UK power sector and calculate that the resulting abatement was between 13 and 21 Mt in 2005 and between 14 and 21 Mt in 2006. A number of studies also present evidence of abatement based upon surveys and interviews Sandoff & Schaad (2009), however they do not allow for quantification.

Table 1 Does the EU ETS drive GHG abatement?

	Ex-ante			**Ex-post**		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total	4	2		16	4	2
Theory based evaluation						
Econometric /statistical analysis				4	2	
Top down modelling	1					
Bottom up modelling	2			3		1
Multi criteria analysis				1		
Surveys						
Data analysis	1	2		7	2	1
Interviews						
Event studies						
Case Studies						
Other				1		

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

2 Over allocation was measured by the surplus of allowances issued to verified emissions.

3 The EUA spot price dropped from €29.20/tCO_2 on Monday the 24th of April 2006 to €13.35/tCO_2 at the end of that week following the first publication of verified emissions data (which was lower than the market anticipated) and the EUA spot price continued to decline to €0.08/tCO_2 by the end of 2007 as banking from Phase I to Phase II was not allowed and the market was long in allowances (Venmans, 2012).

According to the EEA (2013b), EU ETS emissions increased slightly between 2005 and 2007 reflecting the over allocation of allowances that occurred in the first trading period. However in the second trading period emissions in the EU ETS decreased significantly from 5% below 2005 levels in 2008 to 16% below 2005 levels in 2012.[4] The impact of the economic recession on emissions increased the difficulty of evaluating the impact of the EU ETS on GHG abatement as previous BAU projections from Phase I are no longer suitable for Phase II (Egenhofer et al. 2011b). Gloaguen & Alberola (2013) therefore constructed a new BAU baseline from which to estimate GHG abatement in the EU ETS according to different explanatory factors between 2005 and 2011. To overcome the recent volatility, they prolong trends observed over one or two decades prior to 2005 and 2011 to construct their BAU baseline.[5] Based upon an econometric analysis, Gloaguen & Alberola (2013) suggest that the total EU ETS reduction of 1,100 Mt CO_2 between 2005 and 2011 could be allocated mainly to the collective impact of the RES and EE Directives (between 600 to 700 Mt CO_2 reduction), the economic recession (300 Mt CO_2 reduction) and price substitution effects induced by coal and gas prices (200 Mt CO_2 reduction). Although the impact of the carbon price was not directly modelled in the analysis, Gloaguen & Alberola (2013) conclude that the impact of the economic recession combined with the increased deployment of RES were likely to have supressed the carbon price and therefore its impact on GHG abatement.

The impact of other EU policies (i.e. RES & EE Directives) and reduced activity due to the economic recession resulted in the accumulation of a large surplus of allowances, which were further exacerbated by the increased use of international offsets in Phase II (which allowed participants to retain EUAs by surrendering purchased offsets instead – thus adding to the surplus). Hu et al. (2014) calculate a cumulative surplus of allowances of 1,776 Mt in Phase II, of which 41.5% resulted from the over supply of allowances and 58.5% from the use of offset credits. The impact of such a surplus is that it may delay domestic activities and risk locking the EU into carbon intensive infrastructure making the long term EU ETS cap too expensive to achieve Taschini et al. (2014). Given the current political decisions around the 2030 Framework and the ongoing discussion of reforming the EU ETS, Hu et al. (2014) perform an ex-ante estimation of domestic (or internal) abatement resulting from the EU ETS up to 2030 compared to a baseline scenario without the EU ETS (based upon a GDP growth rate and an extrapolation of historic trends of emission intensity improvements). They claim that the introduction of approved policy interventions (i.e. backloading, 2.2% linear reduction factor and market stability reserve) and the inclusion of aviation will be insufficient to return scarcity to the market before 2021 and that EU internal abatement cannot be guaranteed until 2023. They argue for the early removal of the 900 Mt of backloaded allowances by 2020 and broadening the scope of the EU ETS to further encourage domestic abatement in Phase III and beyond.

To what extent has the EU ETS promoted low-carbon investments and supported the competitiveness of European firms in the short and longer term?

Investments

There is a consensus within the literature reviewed that the EU ETS is unable to deliver both low cost GHG reductions and promote low-carbon technology (Table 2) as the objectives conflict with one another. Uncertain and currently low EUA prices have failed to promote low-carbon

[4] The EU ETS cap for 2012 was 6% below 2005 levels (EEA 2013b)

[5] The BAU baseline assumed GDP growth of 1.6% per year, limited development of renewables, less marked increase in energy efficiency, a constant carbon price of €1/t and an energy ratio constant at 2005 levels.

technologies and complementary policies may be necessary to improve the dynamic efficiency of the EU ETS.

The promotion of low-carbon technology is necessary in order to decrease the costs associated with long-term high levels of abatement (i.e. in line with the 2050 target of 80 to 95 % reduction below 2005 levels), which relates to the long term or dynamic efficiency of the EU ETS to reduce emissions at the lowest overall costs Taschini et al. (2014). Intermediate technologies, such as combined cycle gas turbines or coal efficiency, reduce the cost of emission reductions in the medium term. However, investment in these technologies fail to decrease the cost of high levels of abatement due to the fact that ultimately these technologies will need to again be replaced in order to attain more ambitious emission reductions before 2050 and beyond. Given the volatility experienced with EUA prices during Phase I and II of the EU ETS and the sustained low EUA prices observed in Phase III a debate has emerged within the literature about the extent to which the EU ETS can promote low-carbon investments.

Indeed, Blanco & Rodrigues (2008) demonstrate the importance of complementary policies to the EU ETS to support the development of low-carbon technologies. Blanco & Rodrigues (2008) emphasise that all six of the Member States in the EU with more than 250 MW of wind power installed in 2006 had adopted feed in tariffs (or equivalent regulation) that was equivalent to a carbon price between €25 /t CO_2 (i.e. UK) and €159 /t CO_2 (i.e. Italy).[6] The divergence in the equivalent carbon price for these complementary policies reflects the certainty of revenue necessary to support such capital intensive investments. Whereas Germany, Spain, France, Portugal and the UK provide payments that are either fixed or within a narrow band for a guaranteed period of time, the Italian policy is more uncertain with the implementation of a CO_2 certificate market making revenues less predictable. Given that the EU ETS only provides a low incentive for investment in low-carbon technology, Capros et al. (2008) suggest that a RES target is necessary to accompany the EU ETS and support investment and innovation.

Hoffmann (2007) conducted interviews with German electricity producers that accounted for 80 % of the sector's emissions in the country to evaluate the impact of the EU ETS on investment decisions. Hoffmann (2007) concludes that the EU ETS may have incentivised small scale investments with quick pay backs however, as a consequence of regulatory uncertainty, the influence of the EU ETS in large scale investments were found to be limited in Phase I. Löfgren et al. (2013) provide further evidence to support the previous findings based upon an econometric analysis using firm level data between 2002 and 2008. They find that the effect of the EU ETS on the investment decisions on Swedish firms is limited in Phase I and suggest that the generous over allocation of allowances may partly explain the outcome. Chappin & Dijkema (2009) adopt a bottom up model to simulate the influence of the EU ETS on the investment decisions of power companies in the Netherlands. They find that, compared to a 'no intervention' baseline, the impact of the EU ETS on the power generation mix and CO_2 emissions is relatively small and late (based carbon prices ranging from €10/ t to €50/ t). The use of coal is 'unavoidable' driven by expectations of low coal costs and increased electricity demand in the future (Chappin & Dijkema 2009).

[6] Countries within this range of equivalent carbon prices for RES support include Germany (€40.64 /tCO_2), Spain (€33.30 /tCO_2), France (€31.30 /tCO_2) and Portugal (€24.47 /tCO_2)

Table 2 **Does the EU ETS promote low-carbon investments?**

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total		2	1	5	14	6
Theory based evaluation					1	
Econometric /statistical analysis				2	2	1
Top down modelling						
Bottom up modelling		1	1		1	
Multi criteria analysis					1	
Surveys				1	4	1
Data analysis		1			1	3
Interviews				2	1	1
Event studies						
Case Studies					3	
Other						

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

The literature also includes studies that examine the positive impacts of the EU ETS on innovation, which with high rates of diffusion, could reduce carbon leakage. Martin et al. (2011) completed semi-structured interviews with approximately 800 European manufacturing firms (450 of which were regulated by the EU ETS) and concluded that the EU ETS had a positive effect on process innovation (i.e. operational innovations) but not on product innovation (i.e. technological advancement). However, future emission reductions from technological change may still be encouraged by the EU ETS with Calel & Dechezlepretre (2013) estimating that the scheme may be responsible for up to 30% of the increase in low-carbon patenting of regulated companies since 2005. Indeed, based upon a review of corporate investor communications between 2004-2009 for the five most carbon-constrained European Utilities Hervé-Mignucci (2011) find that stricter NAPs in Phase II and expectations of further constraints in Phase III triggered the cancellation of highly carbon-emitting plants. However, the research was limited by the quality of the investment data available and Hervé-Mignucci (2011) calls for greater transparency in future reporting.

Carbon leakage and competitiveness

The consensus from the literature reviewed is that no leakage has occurred yet, which shows a difference between ex-ante expectations and ex-post empirical analysis (Table 3). No detrimental impact on competitiveness has been observed (Table 4). This may be due to economic shocks and carbon leakage provisions. There is a high level of uncertainty on the potential extent of (future) investment leakage.

In order to alleviate the concerns of participating firms in the EU ETS, allowances were initially grandfathered in Phase I and II to offset any potential competitiveness effects of unilaterally pricing carbon. It was strongly argued by industrial stakeholders that the EU ETS would have a negative impact on their competitiveness and undermine the environmental integrity of the scheme by forcing production activities to relocate outside of the EU resulting in the 'leakage' of emissions. Free allocation continued in Phase III for sectors and sub-sectors deemed to be at risk of carbon leakage based upon carbon cost and trade intensity metrics. The first carbon leakage list[7] determined for 2013-2014 was widely criticised for allowing too many firms to be eligible for free allocations based upon their trade intensity regardless of the carbon intensity of their production (Clò, 2010; Droege & Cooper, 2010; de Bruyn et al. 2013; Martin et al. 2014). Indeed, Clò (2010) argues that if only an integrated approach[8] was followed (i.e. not exempting sectors based only on exceeding a threshold for one of the two metrics), instead of 140 exempted sectors out of 257 being entitled to receive free allowances just six sectors would have been exempted. Okereke & McDaniels (2012) suggest that the vulnerability of firms in the steel sector may have been exaggerated for political and economic reasons.

According to Reinaud (2008) there are several channels of sector led-carbon leakage initiated by uneven carbon constraints which include:

- Short term competitiveness channel: 'Where carbon constrained industrial products lose international market shares to the benefit of unconstrained competitors'.
- Investment channel: 'Where differences in returns on capital associated with unilateral mitigation action provide incentives for firms to relocate capital to countries with less stringent climate policies'.
- Fossil fuel price channel: 'Where reduction in global energy prices due to reduced energy demand in climate constrained countries triggers higher energy demand and CO_2 emissions elsewhere, all things being equal'.

Carbon leakage rates have been estimated within the literature for several sectors that are expected to be at significant risk of carbon leakage (i.e. iron and steel, cement and aluminium) via ex-ante modelling approaches (i.e. top down and bottom up models). Depending upon the modelling approach, the studies within the literature tend to focus on particular channels of carbon leakage. Carbon leakage rates range considerably in the literature reviewed from 2% to in excess of 100% for sectors covered by the EU ETS and primarily focus on the short run competitiveness and investment channels of leakage. The lower rates of leakage within this range tend to assume a relatively low-carbon price and preventative measures such as free allocation or border tax adjustments (Kuik & Hofkes 2010; Demailly & Quirion 2008) while the more extreme carbon leakage rates assume a relatively high carbon price and no preventative measures (Ponssard & Walker, 2008; Vivid Economics, 2014). The underlying assumptions of the modelling approach (i.e. energy and trade elasticities) are also of importance in determining the rate of carbon leakage. It is evident that comparison between studies is problematic due to the lack of transparency in modelling approaches and this currently prevents the literature from providing a more definitive answer on the question of carbon leakage.

Interestingly, the results of ex-ante modelling are not validated in the most recent empirical ex-post studies. For example, Dechezleprêtre et al. (2014) examine the impact of the EU ETS on the geographical distribution of carbon emissions with multinational companies between 2007 and 2009. Based upon a regression analysis of 435 companies they find no evidence that the EU ETS

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7 The first carbon leakage list was adopted by the European Commission in 2009.

8 A sector was deemed to be at risk of carbon leakage if it exceeded a 30% threshold for either trade intensity or carbon cost metrics. In addition, a sector was also eligible for free allowances if its trade intensity metric exceeded 10% and its carbon cost metric by 5% (i.e. referred to by Clò (2008) as an integrated approach)

has resulted in a relocation of emissions from Europe towards the rest of the world. Impacts on the EU ETS on competitiveness are also often examined in the ex-post literature to determine the extent of carbon leakage.

Table 3 **Is there evidence of carbon leakage?**

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total	11	3	4		14	1
Theory based evaluation						
Econometric /statistical analysis		1			7	
Top down modelling	5				1	
Bottom up modelling	5		2		1	
Multi criteria analysis						1
Surveys		1			2	
Data analysis	1		1		2	
Interviews		1	1		1	
Event studies						
Case Studies						
Other						

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

Chan et al. (2013) use a panel of 5873 firms in 10 European countries between 2001 and 2009 to econometrically assess the impact of the EU ETS on three variables 1) unit material costs 2) employment and 3) revenue. No negative impacts are found for all three variables in the cement and iron and steel sectors and concluded that competitiveness concerns are unsubstantiated. Abrell et al. (2011) assess the impact of the EU ETS on the value added, the profit margin and employment of participating firms over Phase I and the start of Phase II for a sample of European firms using performance data from the AMADEUS database. They find no statistically significant impact on a company's value added and profit margins as a result of firms participating in the EU ETS. Furthermore, Anger & Oberndorfer (2008) find no influence of the allocation factor on either revenues or employment after conducting an ex-post regression analysis for 419 German firms in the EU ETS. Focusing on the aluminium sector, both Reinaud (2008) and Sartor (2012) conduct an ex-post econometric analysis of the impact of the EU ETS on aluminium imports and both find no evidence, yet, to support claims of competitiveness losses and carbon leakage.

Evidence of carbon leakage associated with the investment channel of carbon leakage has been considered by Martin et al. (2012) whom conducted a larger study consisting of 761 interviews with managers in six European countries. In response to carbon pricing, the managers were asked whether or not the company intended to either downsize operations or relocate abroad until 2020. Furthermore, for managers representing firms in the EU ETS the interview was structured to determine the importance of the continuation of free allowances post 2012 in their decision making. Based upon the interview responses the authors compiled 'downsizing risk scores' that captured the subjective risk of downsizing with and without free allocation. The outcome of the study was that the downsizing risk was generally low, with the majority of firms reporting no impact on where to locate business activity based upon future carbon pricing. However, the downsizing risk score was higher for firms participating in the EU ETS compared to non-ETS firms. Furthermore, the authors identified that a high level of variation existed amongst the firms in the EU ETS with regards to the downsizing risk associated with carbon pricing and the effectiveness of free allocation as a preventative measure.

Table 4 Has the EU ETS negatively affected the competitiveness of firms?

	Ex-ante			**Ex-post**		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total	1	4	4	1	20	7
Theory based evaluation						
Econometric /statistical analysis		1			9	2
Top down modelling		1				
Bottom up modelling			2		1	
Multi criteria analysis					1	
Surveys		1			2	1
Data analysis			1	1	3	3
Interviews		1	1		2	1
Event studies					1	
Case Studies					1	
Other	1					

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

The empirical findings above suggest that the impact of the EU ETS on competitiveness may be limited over Phase I and II, which may in part be due to the allocation of free allowances to industry and the relatively low EUA prices experienced towards the end of Phase II. However, the limited data available and the difficulty in disaggregating the impact of the EU ETS from other drivers of competitiveness necessitates future research. In addition, the reform of the EU ETS in Phase III and beyond may impact upon future competitiveness depending on how 'appropriate measures' to support industry are defined within the 2030 Framework negotiations. It is also important to acknowledge that the impact of the EU ETS on investments is currently constrained by limited data availability hindering efforts to provide further clarity on the extent of carbon leakage from the investment channel.

3.2.2. Efficiency

Efficiency refers to an assessment of whether the costs associated with the input to an intervention were justified given the effects which have been achieved (European Commission, 2013). Generally, the assessment of efficiency needs to be distinguished from an assessment of cost-effectiveness of an intervention. Efficiency refers to a state where the goal (i.e. emissions reductions) is achieved at a level so that the marginal abatement costs are equal to the social costs of carbon (thus comparing the cost of action to the cost of inaction). Cost-effectiveness refers to achieving a given target at the lowest possible costs (as in the case of the EU ETS by equalising marginal abatement costs across industries and countries through a common carbon price to achieve the EU ETS cap). In the context of efficiency evaluation of the EU ETS the terms cost efficiency and cost effectiveness are most often used interchangeably and refer to achieving the EU ETS cap at least cost. This section of the literature review responds to the following questions:

How efficient is the implementation of the EU ETS in both the short and longer term?

Price signal

If the price signal is determined by market fundamentals this implies that the carbon price reflects marginal abatement costs and therefore the market functions efficiently (Table 5). Studies show ambiguous results, however most support the hypothesis that price is driven by market fundamentals.

The EU ETS operates through the establishment of an intended price signal through the supply and demand of emission permits in the EU ETS, which provides an incentive for GHG abatement. In order for the EU ETS to function efficiently, the price signal needs to reflect marginal abatement costs and therefore must be determined by market fundamentals (e.g. prices of other inputs, economic development etc.). Ex-post econometric evidence from the literature indicates that EUA prices are driven, at least to a certain extent, by market fundamentals. For example, fuel prices are widely considered the most important drivers of EUA prices, as fuel switching from coal to natural gas provides a short-term opportunity to reduce CO_2 emissions for power generators (Bunn & Fezzi, 2007; Mansanet-Bataller & Chevallier, 2010; Alberola, 2008; Keppler & Mansanet-Bataller, 2010). The effect of weather events and temperature on electricity prices has also been identified as additional variables that impact upon the EUA price (Alberola, 2008; Rickels, 2010; Schumacher et al., 2012).

However, the extent to which market fundamentals drive the EUA price has been questioned in the literature. For example, Koch et al. (2014) finds that 90 % of the variations of EUA price changes observed between January 2008 and October 2013 (where the EUA price declined from €30 to €5) remain unexplained by abatement related fundamentals. Even after accounting for the impact of the unexpected change in economic conditions, and to a lesser extent, the increased deployment of wind and solar energy, Koch et al. (2014) suggests that non-market fundamental factors (e.g. policy decisions or announcements, speculation etc.) also contributes to the observed trend. Indeed, an ex-ante modelling analysis by Blyth & Bunn (2011) identifies policy (i.e. uncertainty in level of cap & technological support), market (i.e. uncertainty in demand for electricity & fuel prices) and technology (i.e. uncertainty in cost and quantity of abatement) risks to price formation in the EU ETS. They argue that immature markets are especially at risk to policy uncertainties that may initially weaken the price signal. For example, the collapse of the EUA price towards the end of Phase I, due to the inability of market participants to carry over allowances into Phase II, demonstrated how institutional and market events can also drive allowance price changes (Alberola, 2008).

Table 5 Is the price signal of the EU ETS driven by market fundamentals?

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total		1		21	3	4
Theory based evaluation						
Econometric /statistical analysis		1		20	3	4
Top down modelling						
Bottom up modelling				1		
Multi criteria analysis						
Surveys						
Data analysis						
Interviews						
Event studies						
Case Studies						
Other						

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

It is likely that the low price signal at the beginning of Phase III was driven primarily by market fundamentals, responding in particular to reduced demand for EUAs as a consequence of the reduced expectations for growth in the Eurozone. The introduction of the backloading decision to address the surplus of allowances that were carried over from Phase II of the EU ETS is an example of non-market fundamentals also influencing the price signal. This political intervention and the proposed introduction of a Market Stability Reserve, to enable greater flexibility in the supply of EUAs, prompts a debate within the literature about how efficiency is defined concerning the implementation of the EU ETS. From a static efficiency perspective, the price signal is currently delivering low cost GHG abatement. However, Taschini et al. (2014) argues that from a dynamic efficiency perspective, current policies may not allow long term targets to be reached at least cost. The objective of the EU ETS may require further clarification to ensure that the policy instrument is efficiently implemented in the future.

Transaction costs

The literature reviewed suggests that transaction costs are higher in a cap and trade scheme than in a carbon tax. Transaction costs were reasonably low for the larger emitters, however transaction costs were comparably high for smaller emitters (Table 6).

The transaction costs associated with the EU ETS are considered in the literature to be more expensive than a simpler carbon tax, which is more transparent and easier to apply (Jaraite et al. 2009). They categorise compliance costs associated with the EU ETS as including:

- Start up costs, which may include estimating baselines and measuring equipment;

- Monitoring, reporting and verification (MRV) costs, which may include compiling annual emissions reports and hiring an accredited emissions verifier;
- Trading costs, which may include accessing the carbon exchange or paying brokerage fees.

Based upon a survey of 27 Irish firms, Jaraite et al. (2009) find that the transaction costs per tonne of CO_2 emitted were much higher for the smaller operators in Phase I of the EU ETS. In comparison to the average cost per tonne of CO_2 emitted for all firms for set up and MRV activities of €0.08, small firms experienced relatively higher transaction costs of €2.02. Based upon survey data from German companies in the EU ETS, Heindl (2012) estimates that overall annual transaction costs in Germany amount to €8.7 million with MRV costs responsible for 69 % of the total cost. At a more disaggregated level of analysis, Heindl (2012) also finds that transaction costs per tonne of CO_2 are relatively higher for smaller firms compared to larger firms. Sandoff & Schaad (2009) support the findings of Jaraite et al. (2009) by surveying 114 Swedish companies and reveal that a mean time investment of 27 man hours per month were required for EU ETS compliance. The amount of time required varied based upon the size of the firm, ranging from 17 to 42 hours for small and large firms respectively. Over 40% of the respondents claimed that the transaction burden on firms with low emissions were too high. However, Sandoff & Schaad (2009) conclude that time investment is fairly moderate.

Table 6 Are transaction costs in the EU ETS too high?

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total				4	7	
Theory based evaluation				1	1	
Econometric /statistical analysis				2		
Top down modelling						
Bottom up modelling						
Multi criteria analysis					1	
Surveys				1	3	
Data analysis					1	
Interviews						
Event studies						
Case Studies					1	
Other						

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

To what extent has the allocation method of distributing allowances affected the efficient functioning of the EU ETS?

Whereas the immediate cost efficiency of the EU ETS is independent of the allocation form of emissions rights, indirect economic impacts in terms of, for example, distributional effects are directly linked to the allocation design. In Phase I and II allowances were primarily allocated to participating installations based upon their historic emissions (i.e. grandfathering). The allocation rules were initially decided at the Member State level, which resulted in competitive distortions as a consequence of NAPs being designed differently (Matthes et al., 2005). In addition, these NAPs were subject to manipulation in Phase I with over the allocation of allowances for many sectors. Although more stringent NAPs were set in Phase II, they were agreed prior to the economic recession and a surplus of over 1.8 billion allowances were carried over at the start of Phase III (EEA, 2013a). The opportunity costs associated with these freely allocated allowances were, and to a certain extent still are, passed through to burden consumers with power plants operators benefiting from increased revenues and windfall profits.

As a result of these regressive impacts, allowances will only be allocated for free in Phase III based on product specific benchmarks, which reflect the average GHG performance of the most efficient 10% of producers thereby also encouraging innovation. According to the EEA (2014) the introduction of benchmarking has already impacted upon certain sectors with refineries only being freely allocated 80% of their verified emissions in 2013 – indicating that the over allocation experienced in Phases I and II may be better addressed in Phase III. The design of the benchmarks will be subject to further negotiation with many stakeholders from industry advocating the introduction of dynamic allocation (Borkent et al., 2014) as the current benchmarks are multiplied by historic production levels to calculate free allowances rather than current levels of production potentially impacting upon industrial competitiveness. An increasing share of all of the allowances in Phase III (approximately 50%) will be auctioned (EEA, 2014) with revenues from auctioning benefiting governments or consumers instead - reducing the pass through of costs and windfall profits experienced in Phase I and II.

Cost pass through

There is a general consensus in the literature reviewed that in the energy sector there has been a substantial pass through of carbon costs and windfall profits. There is evidence emerging that the energy intensive sector has also benefited from free allocation in Phase I and II of the EU ETS (Table 7)

The cost pass through rate can be generally described as the change in output price in response to a change in input costs and serves in the literature as a proxy measure of both windfall profits and competitiveness. If costs are not passed through, then firms need to bear the additional costs and their profits will fall. If costs are passed through and result in higher product prices, this may affect production and competitiveness as follows: 1) domestic demand may be lost as consumers may decide to buy alternative and less expensive domestic substitutes or imported products (only the latter effect is associated with carbon leakage); 2) Export shares may be lost to countries that are not subject to comparable policies (Graichen et al. 2008). Whether these effects are likely and costs are passed through, and to which extent, depends mainly upon three factors outlined by Varma et al. (2012):

- Market structure refers to the number of firms in the market and the level of state intervention either by regulation or direct ownership. The structure of the market determines the level of competition between firms and influences the ability of firms to pass on additional CO_2 costs without losing market share.
- Supply and demand elasticities refer to the degree to which supply or demand of a product responds to a change in price. If the demand elasticity of a product is zero (i.e. rigid

demand) then additional CO_2 costs can be passed through with no risk of a firm losing market share.

- Exposure to international trade also influences the ability of a firm to pass through additional CO_2 costs. For example, if the exposure of a firm to international trade is low then higher product prices due to passing through additional costs do not impact on the competitiveness of the firm.

In theory, under perfect competition industries can pass through 100% of their costs (compare Sijm et al., 2008). Extending the theoretical discussion further to estimate cost pass through for unilateral cost increases, de Bruyn et al. (2010) argue in the context of the EU ETS that even if initially the additional carbon cost is fully passed through, the impact of imports from other countries will ultimately lower the total price increase in sectors that are exposed to international competition. This argument is based upon the 'Law of One Price' principle, which assumes that markets are perfectly integrated with identical commodities having the same price internationally. However, as indicated by Armington (1969) perfectly integrated markets rarely occur as products produced in different countries are often imperfect substitutes due to product differentiation and transportation costs.

In the real world of less than perfect competition, less than perfectly integrated markets and uncertainty over supply and demand elasticities an empirical analysis of the input and output prices of products is necessary in order to translate theory of cost pass through into reality. Sijm et al. (2008) assess the impact of the EU ETS on electricity prices based upon an ex-post regression analysis. They estimate the cost pass through rates on forward markets during peak and off peak periods in 2005 and 2006 for five countries (France, Germany, the Netherlands, Sweden and the UK). They find that 17 out of 22 estimates range between 38 to 83%, 4 estimates are slightly above 100% and one anomaly is estimated at 182%. Solier (2011) completed an updated assessment using an econometric model to assess cost pass through rates for ten countries between June 2005 and April 2011. They find that while the impact of the CO_2 was relatively strong in Phase I, the economic crisis at the onset of Phase II resulted in higher market instability that disrupted efforts to estimate carbon cost pass through rates.

Based upon empirical data from the first two phases of the EU ETS attempts have been made in the literature (Alexeeva-Talebi 2010; Oberndorfer et al. 2010) to estimate the extent to which costs have been passed through into industrial product prices. Oberndorfer et al. (2010) shows that with the exception of ceramic goods, the remainder of the products assessed are able to pass through only parts of their costs into output prices. Ceramic goods show a pass through rate of larger than 100% which is a result of certain market characteristics and can be interpreted as a complete pass through of policy induced carbon costs. Alexeeva-Talebi (2010) agrees that producers of cement, lime & plaster are capable of passing through the majority of additional costs and also identifies a wide range of cost pass through rates that exist across the different sectors (i.e. 0% to 75%). Both studies calculate different cost pass through rates for hollow glass, which reflects the use of different data, different lengths of their time series and/or different specification of their estimated equations (i.e. which input costs the authors consider in their estimation on the one hand side and which commodity prices (retail, consumer) are to be explained).

Table 7 **Do firms completely (or substantially) pass through their carbon costs into product prices?**

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total	7		3	13	4	9
Theory based evaluation	1		1	1		2
Econometric /statistical analysis	2		1	9	3	5
Top down modelling						
Bottom up modelling	3		1	2		2
Multi criteria analysis						
Surveys						
Data analysis						
Interviews	1			1	1	
Event studies						
Case Studies						
Other						

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

Further evidence of the variability of the cost pass through rate is provided more recently by Vivid Economics (2014) based upon an ex-ante analysis using bottom up models.[9] In particular, they find that the aluminium sector is associated with low levels of cost pass through (absorb more than 80% of the cost increase) due to the fact that the commodity is 1) traded on a global market 2) has a very low weight to value ratio and 3) there is sufficient global capacity. In contrast, Vivid Economics (2014) identify the malt sector as being able to fully pass through their carbon costs as a consequence of the absence of non-EU competition. The majority of the other sectors considered in the study were estimated to have cost pass through rates above 75%, however it is stressed within the study that high pass through rates do not necessarily prevent firms experiencing cost shocks that impact upon their competitiveness. In addition, simplified assumptions within the modelling (i.e. all firms treated the same regardless of geographical location) means that in reality cost pass through rates may be lower for firms located on the coast or nearer to non-EU borders.

Windfall profits

Evidence in the literature reviewed shows that In Phase I and II of the EU ETS windfall profits were high especially for electricity producers, transferring billions of euros from consumers to shareholders.

[9] 'The Industrial Market Models calculate cost pass-through rates as a function of the various parameters that describe the competitive structure of the market; that is, it is an output, rather than an input, to the model' (Vivid Economics, 2014).

Sijm et al. (2008) estimates the extent of windfall profits in the power sector by modelling scenarios for 20 Member States that assume different market structures, carbon prices and demand elasticities. Sijm et al. (2008) estimates that EU-20 power windfall profits ranging from €24 to €28 billion based upon two scenarios that assume either oligopolistic or perfect competition, a carbon price of €20 and demand elasticity of 0.2. Keppler & Cruciani (2010) conduct a similar ex-ante analysis to estimate windfall profits in the power sector of €19 billion a year during Phase I of the EU ETS based upon the modelling assumption of full opportunity pass through and a mean carbon price of 12 €. Given that the Sijm et al (2008) study assumes a carbon price above the mean price of Phase I, Venmans (2012) concludes that windfall profits for the power sector in Phase I of the EU ETS are likely to have ranged between €19 and €25 billion per year. Windfall profits were not, however, exclusive to the power sector. de Bruyn et al. (2010) estimates that energy intensive industries may have received €14 billion between 2005 and 2008 based upon the outcome of an econometrical analysis of cost pass through rates for refinery and iron and steel products.

Point Carbon (2008) estimates windfall profits that ranged from €23 to €63 billion during Phase II of the EU ETS (2008-2012) based on an EUA price of €21 to €32 and a range of different cost pass through assumptions using a bottom up model. It is argued that the ability of a country to obtain windfall profits in Phase II of the EU ETS depended on:

- The level of cost pass through of CO_2 costs to wholesale power prices;
- The emissions intensity of a country's power mix to enable a country with emission intensive plants such as coal to set the electricity price for the majority of the time and;
- The allocation of a high percentage of free allowances to the power sector from each country's National Allocation Plan (NAP).

The highest level of windfall profits in the power sector was expected to occur in both Germany (between €14 and €34 billion) and the UK (between €6 and €15 billion). Interestingly, windfall profits are lower in the UK than Germany due to the fact that gas plants set the marginal price more often in the UK and also because of the relatively low level of free allocation to power installations in the country's NAP (Point Carbon, 2008). In contrast, the ex-ante modelling demonstrated that countries with a power mix dominated by low-emitting technologies were expected to experience lower levels of profit such as Spain (between €1 and €4 billion).

Despite the establishment of auctioning as the primary method for distributing allowances, Keppler, & Cruciani (2010) estimate that power companies will still receive windfall profits of €10 billion per year in Phase III based upon the modelling assumption of full auctioning and a carbon price of €20. Windfall profits will continue to arise due to the fact that low-carbon producers of electricity continue to obtain profits when high carbon producers are the price setting technology. The impacts of windfall profits are expected to diminish if the share of allowances that are auctioned continues to increase over time . However, the ongoing carbon leakage debate will continue the risk of potential windfall profits in the future depending upon the share of free allowances that remain available in Phase III of the EU ETS and beyond.

3.2.3. Coherence

Coherence refers to the extent to which a policy intervention compliments and supports other policy interventions which may have similar objectives. In the case of the EU ETS, the way in which the policy instrument interacts with other EU policies needs to be evaluated in order to determine the success of the policy intervention. This section of the literature review responds to the following question:

How well does the EU ETS complement other EU climate and energy policies?

Coherence

There is a general consensus within the literature reviewed that the impact of other policies such as the Renewable Energy (RES) and Energy Efficiency (EE) Directives have mitigated the price signal of the EU ETS (Table 8). However, it is important to acknowledge that the explicit objective for the EU ETS to incentivise low-carbon investment was set after the RES and EE Directives were adopted.

In theory, the policy mix of instruments adopted should result in a series of complementary interactions between the 20/20/20 targets to facilitate compliance at both the EU and Member State level. For example, the development of RES results in gross avoided GHG emissions and reduces primary energy production, which helps meeting not only the GHG target but also the EE target. At the same time, EE gains in a number of sectors such as buildings or transport represent key contributions towards achieving national non-ETS targets. They may also affect the demand for electricity generated within the EU ETS and reduce the quantity of renewable energy needed to meet the RES targets. In turn, the GHG target might induce investment into EE or RES projects, in particular if the ETS allowance price increases. Moreover, the GHG target might stimulate behavioural changes (e.g. lower space heating temperature) through either the EU ETS price signal or through the non-ETS target and its accompanying policies and measures. However, in practice, determining the optimal mix of policy instruments to support the achievement of the 20/20/20 targets is more problematic and results in both complementary and countervailing interactions.

From a complementarity perspective, the interactions of the policy instruments may help to improve policy design and implementation, correct for market failures and meet additional policy objectives. For example, in the case of the EU ETS, low EUA prices have failed to provide the price signal necessary to drive systematic innovation in RES (Rey et al., 2013) and are deemed too low to support anticipated levels of investment in abatement technologies. The RES Directive has, to a certain extent, offset the impact of the low EUA prices in the ETS by obligating Member States to increase their share of RES via the introduction of RES-E support schemes at the national level. Indeed the introduction of feed-in tariffs in particular has helped to support the innovation of less mature technologies (Rey et al., 2013; Egenhofer et al., 2011a; del Río, 2009). Furthermore, the implementation of EE measures as a consequence of the EE Directive and the Effort Sharing Decision (ESD) have also promoted the uptake of abatement options in Member States that are below the EUA price set by the ETS thus overcoming common barriers (i.e. high capital costs).

From a countervailing perspective, some policies have also been adversely affected by the overlap with other policy instruments. For example, although the EU ETS cap was set in a way that expected GHG reduction effects induced by the binding RES targets until 2020, the overlap inevitably introduced an element of uncertainty as the success of RES policies cannot be predicted with certainty (Rey et al., 2013). As such, the overachievement of the RES target (beyond what was envisaged when setting the EU ETS cap) does not contribute to additional GHG reductions but simply suppresses the EUA price in the EU ETS as the amount of GHG reductions required to fulfil the ETS cap is lowered by the increasing deployment of RES. Weigt et al. (2013) estimated the actual reduction for EUAs between 2006 to 2010 as a consequence of RES deployment in the German electricity sector. They estimated using a bottom up model that CO_2 emissions would have been 10% to 18% higher in a scenario without RES policy, depending upon the year and whether or not the CO_2 price was present. Weigt et al. (2013) further speculates that an 18% reduction in demand for allowances in Germany corresponds to a system wide reduction in demand of 2.7%, which could have a considerable impact on EUA prices - theoretically suggesting an increase higher than 50% compared to observed EUA prices under the assumption of a 5% system wide abatement target and a linear marginal abatement cost curve.

Table 8 Impact of external climate and energy policies on the EU ETS?

	Ex-ante			Ex-post		
	Positive	Negative	Uncertain	Positive	Negative	Uncertain
Total	2	2		1	3	1
Theory based evaluation						
Econometric /statistical analysis					1	
Top down modelling						
Bottom up modelling	2	2			1	
Multi criteria analysis						
Surveys						
Data analysis					1	1
Interviews						
Event studies						
Case Studies						
Briefings						
Other				1		

Note: The numbers refer to methodologies found in the literature that respond to the question in the title above (evaluations may adopt more than one methodology)

Source: Own illustration

Fagiani et al. (2014) simulate ex-ante the impact of carbon reduction and renewable energy policy on investor's choices by using a bottom up investment model to show how energy policy influences the evolution of the electricity sector up until 2050. They find that a 'pure' emissions market[10] achieves its carbon emission reduction target at a discounted cost to society of €5.15/ MWh over the simulation period. However, the scenario results in high allowance prices towards the final years of the simulation as reduction aims are missed due to temporarily low EUA prices in the early phase of the simulation and imperfect forecasting resulting in insufficient investment in low-carbon technologies for complying with the strict 2050 emissions target. Alternatively, Fagiani et al. (2014) show that the RES deployment target is effectively achieved in a scenario with only a green certificate market. However the total social cost (€8.68/ MWh) is higher than under a pure market scenario. Interestingly, they find that a combination of carbon and green certificate markets results in a more stable and lower carbon price in the emissions trading scheme. However, Koch et al. (2014) provide empirical evidence of this interaction effect by conducting an econometric analysis

[10] Defined as a scenario without a renewable energy policy instrument.

of EUA price variation between January 2008 to October 2013. They find that previous simulation based analyses may have potentially exaggerated what is essentially a moderate impact.

The interaction between the EU ETS and the ESD has also been evaluated within the literature with several authors (Betz & Sato, 2006; Clò, 2008) suggesting that the design and implementation of the EU ETS may have actually increased the overall cost of the EU to meet the GHG target for 2020. For example, Clò (2008) argues that the over allocation experienced in Phase I of the EU ETS in several Member States shifted the reduction burden from the ETS to non-ETS sectors. Given that marginal abatement costs are widely considered to be higher (Böhringer et al., 2005; Peterson, 2006) in the sectors not covered by the EU ETS (i.e. buildings, transport etc.), such a shift in the GHG reduction burden may have resulted in overall abatement costs increasing. Böhringer et al. (2006) suggest that such inefficiencies resulted from the successful lobbying by emission intensive industries and that the expansion of the EU ETS would enable the negative interactions between the ETS and non-ETS sectors to be minimised over time.

Indeed, the inclusion of road transport into the EU ETS has been proposed by the European Commission,(2012) as one of the options considered for structural reform. The introduction of such a reform may help to improve the efficiency by which the GHG target is achieved by minimising the negative interactions between the EU ETS and ESD as discussed above. However the political viability of including road transport in the EU ETS has been questioned by Pollitt (2014) who examined different scenarios using a top-down model to ascertain the impact on the average EU ETS price (2020-2030) and on the reduction in road transport emissions in 2030 compared to a reference scenario (based upon PRIMES 2009 modelling). Pollitt (2014) estimates that, if the road transport system would be included in the EU ETS, the average carbon price between 2020 and 2030 would need to be €217 /tCO_2 to deliver emission reductions from the road transport sector (i.e. 60g/km for cars in 2030) that are in line with the long term goal of the EU. Given the high carbon price, it is argued that an alternative scenario whereby fuel standards are applied on new vehicles would achieve the same ambitious emission reduction in the road transport sector at a lower cost to consumers and industry.

3.2.4. EU added value

EU added value refers to the additional value resulting from the EU intervention compared to what could be achieved by Member States at national or regional levels (European Commission, 2013). Given the nature of emissions trading, it is to be expected that the additional value of an EU intervention is primarily to lower compliance costs by facilitating the trade of low cost abatement potential across all of the Member States. However, additional benefits may also include improved levels of governance through enhanced central co-ordination and legal certainty that only the EU can provide to Member States, especially with regards to the EU ETS compliance cycle. However, the effectiveness of the scheme still depends upon the consistent and uniform implementation at the Member State level. There is also a need to evaluate the added value of the EU ETS compared with alternative policies (i.e. carbon tax, emission performance standards) in order to determine whether the same objectives could be achieved by the EU in a more cost effective manner. This section of the literature review responds to the following questions:

To what extent has the implementation of the EU ETS by Member States been improved by the adoption of more harmonised approaches?

Harmonisation and market oversight

Harmonised approaches have generally improved the implementation of the EU ETS by removing the previous distortions caused by Member States interpreting rules differently,

Verschuuren (2012) provides a report on the legal implementation of the EU ETS at the Member State level and finds that, in comparison to command and control type instruments, the monitoring and enforcement efforts associated with an emissions trading market is far more complex. As a consequence of the harmonisation of the rules for verifiers by Regulation 600/2012/EU the regulatory framework for compliance has improved considerably since the start of the scheme in 2005. However, he emphasises that the entire compliance cycle is not yet fully harmonised with Member States retaining control of inspection, sanctioning and checking the compliance of the MRV process. According to Dechezleprêtre (2012) the level of compliance by installation has improved from 91% in Phase I to 97% in Phase II, although rates vary considerably across Member States and this may reflect the different levels of enforcement. Verschuuren (2012) suggests that further harmonisation of the compliance cycle may help to lower rates of non-compliance.

The move towards harmonisation in the EU ETS also extends to the allocation rules for free allowances based upon new benchmarking rules that reward installations with better emissions performance. Lecourt et al. (2013) advocate that the harmonisation of the allocation rules will reduce the differences in allocation levels across countries with similar carbon intensities of production – thus reducing competitive distortions that were previously observed in Phase I and II (Matthes et al., 2005). Furthermore, it is envisaged that the centralisation of allocation rules will help to prevent the over allocation of allowances experienced in Phase I and II through the NAPs of Member States.

The resilience of the EU ETS has also improved through greater levels of harmonisation in response to the VAT fraud, money-laundering and other criminal activities that were uncovered in 2009. The security concerns were swiftly addressed by linking the EU ETS to the EU's financial regulatory instruments (i.e. Market Abuse Directive and Anti-Money Laundering Directive), tightening rules on transactions and by harmonising all of the national registries into a single Union registry (Verschuuren, 2012; Sartor, 2011). Further evaluation of these reforms will be necessary over Phase III to assess the continued resilience of the EU ETS.

Would alternative policy instruments at EU or national levels have been more cost effective than the EU ETS?

Alternative policies

The main focus of the evaluations reviewed is on the added value of EU intervention with scenarios developed to assess the impact of alternative policies such as carbon taxes and emission performance standards or simply no policies at all. The majority of the studies evaluated show that emission reductions are achieved at lower cost by emissions trading than by alternative policies.

The quantitative literature on cost-efficiency of existing or planned emissions trading systems compared to other policy instruments is limited. The approaches found can be classified into three groups: bottom-up approaches that use sector- or firm-specific information, partial-equilibrium models that combine information from different sectors but often lose part of the detailed information that can be found in bottom-up approaches and general equilibrium models that focus on the interaction between sectors instead of using detailed sector- or firm-specific information. Most of those cost-efficiency analyses are ex-ante cost efficiency estimates.

Studies estimating cost-efficiency ex-ante based on modelling exercises include Capros & Mantzos (2000) and the European Commission (2008). In both studies the partial equilibrium model PRIMES is used to estimate costs in a case with emissions trading in contrast to a reference scenario. Capros & Mantzos, (2000) find that under the full trading scenario, the cost of achieving the Kyoto targets for 2008-2012 reduces by almost 75% compared to the no trading scenario. A similar exercise is presented in the European Commission (2008) impact assessment on the 20/20/20 package. Here cost estimates concentrate on the split between the targets for the ETS and the non-ETS sectors as well as the use of offsets. In addition to PRIMES the models POLES and GAINS as well as the general equilibrium models GEM E3 and PACE are used. The impact assessment outlines that it would be more cost effective to deliver the majority (60%) of the reduction effort for the GHG target under the sectors covered by the EU ETS.

In an ex-post study on the cost-efficiency of the EU ETS in comparison to alternative policy instruments of the command-and-control-type (Öko-Institut et al. 2014)[11]), three Tier approaches to assessing cost-efficiency are developed differing by breadth and depths of the desired analysis and data availability. While the suggested Tier 1 approach is based on simple publicly available quantity and price data for the EU ETS, the Tier 2 approach relies on more complex marginal abatement cost curves potentially resulting from bottom-up analysis or partial modeling analysis. The more complex Tier 3 approach requires the use of a model with an adequate representation of the EU ETS sectors and countries. Case study applications of these Tier approaches show lower abatement costs to achieve a given reduction target in all three Tiers. The study highlights that the most important aspects driving the results of an ex-post assessment of the EU ETS include:

- determining the avoided emissions due to the ETS compared to a system without ETS (counterfactual scenario)
- designing the alternative policy scenario without the possibility to trade
- the availability and quality of suitable abatement cost curves
- the choice of the assessment perspective with its trade-off between data requirements and accuracy

The results, therefore, need to be seen in light of the assumptions, data availability and level of detail for these aspects. They differ substantially by Tier approach and therefore show potentially wide ranges in terms of avoided emissions and cost savings compared to an alternative policy scenario.

3.2.5. **Relevance**

Relevance refers to the extent to which the objectives correspond to the needs within the EU (European Commission, 2013). In the context of the EU ETS, the relevance evaluation criteria applies primarily to the need of the EU to reduce GHG emissions - both in line with scientific recommendations and in a cost effective and efficient manner. When reviewing evaluations that consider the extent to which the objectives for the EU ETS correspond to the needs within the EU,

[11] Study titled “Ex-post analysis of cost efficiency in the second trading period of the EU ETS State of the art Methodologies, applications and lessons learned” conducted for the German Federal Environment Agency, to be published in early 2015.

it is important to acknowledge how circumstances may have changed and that the needs may now be different from when the policy intervention was originally designed. For example, the additional objective of promoting low-carbon technology emerged as the dynamic efficiency of the EU ETS (i.e. ensuring that compliance costs are lowered to meet ambitious GHG reductions in the long term by investing in low-carbon technology now) was increasingly questioned in the literature. This section of the literature review responds to the following question:

How well do the objectives of the EU ETS correspond to the needs within the EU?

Relevance of the EU ETS objectives

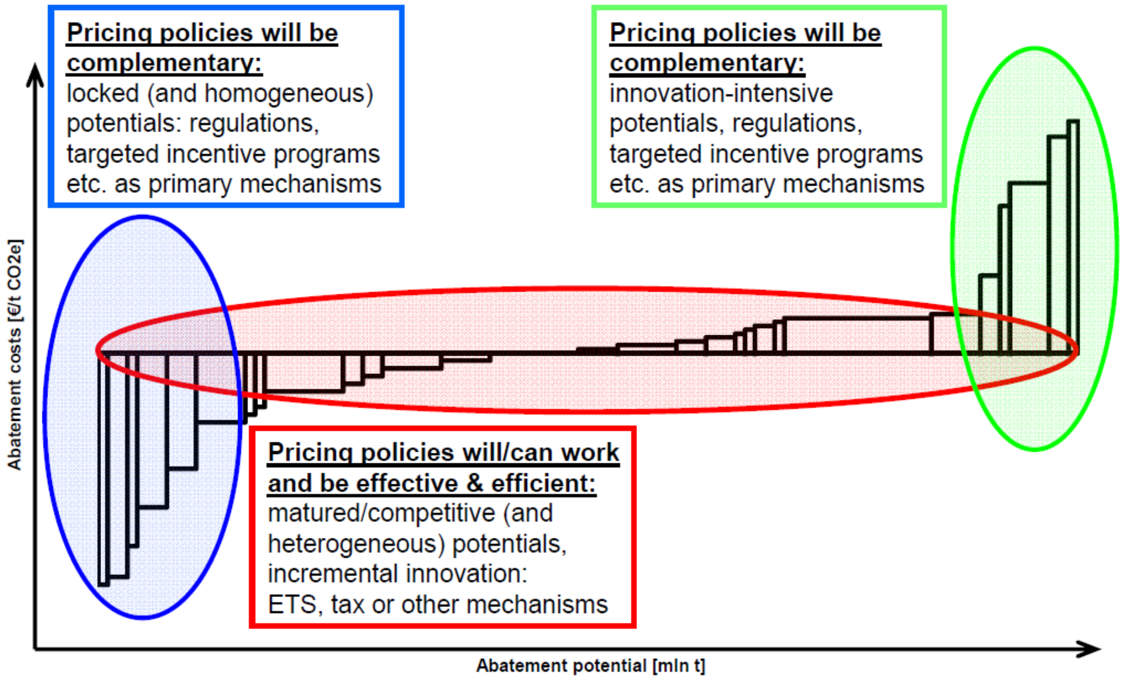
The objectives of the EU ETS do correspond to needs within the EU, however there is currently a debate within the literature reviewed about whether complementary instruments are necessary to support the EU ETS in order to fulfil the needs of the EU.

The objectives of the EU ETS were outlined in Section 2 and were frequently referred to in the literature when evaluating a particular component of the EU ETS architecture. Whether this be evaluating the stringency of the cap in relation to the GHG reductions recommended by the International Panel on Climate Change (IPCC) or assessing carbon leakage provisions to ensure that the competitiveness of participating firms was not adversely affected by the policy intervention – thus reducing emissions in a cost effective and efficient manner. However, the delivery of all of the objectives set for the EU ETS has been frequently discussed within the literature (especially regarding the role of policy instrument in promoting low-carbon technologies) leading to questions being asked about the future role of the EU ETS. Matthes (2010) provided further clarity on this particular question in a theroetical analysis of the need for a climate policy mix. The red circle in Figure 6 shows the abatement measures that will most likely be influenced by pricing policies such as the EU ETS. According to Matthes (2010) the advantages of the EU ETS include:

1) Provides greater security that a GHG reduction target will be meet;
2) Generates a price signal for a range of abatement options close to market;
3) Increases the globalisation of climate policy through the possibility of linking emission trading schemes and other flexible mechanisms.

Given that only incremental innovations have been observed in the EU ETS, Matthes (2010) argues that complementary policies (i.e. incentive programs, regulations) are necessary in order to realise the higher cost abatement potential in Figure 6 represented by the green circle. Indeed, Aghion et al. (2009) suggest that R&D investments need to be increased in combination with a higher and more stable carbon price. On the otherside of the abatement cost curve, the blue circle in Figure 6 indicates abatement potential at negative cost that is currently unable to be realised due to market barriers. Matthes (2010) again indicates that complementary policies (i.e. incentive programs, regulations) will be necessary in addition to the EU ETS. It is important to also acknowledge that any extension in the scope of the EU ETS in the future may make some of these complementary policies obselete (Matthes, 2010). The relevance of the EU ETS in the future climate policy mix was reaffirmed in the European Council Conclusions of October 2014, however it is evident that complementary policies may be necessary in order to support the policy instrument in delivering on all of its objectives.

Figure 6 Relevance of the EU ETS in the future policy mix



Source: Matthes (2010)

3.3. Summary

Throughout the literature review it was evident that the objectives of the EU ETS have responded to the changing needs of the EU over time. The environmental stringency of the cap has been progressively strengthened throughout the phases of the EU ETS. The stricter enforcement of NAPs by the European Commission in Phase II and the transition to a harmonized EU wide cap that declines in line with an annual linear reduction factor from Phase III onwards demonstrates how the design of the EU ETS has improved to fulfil the need of the EU to achieve ambitious emission reductions. As discussed in Section 3.2.1 the reform of the ETS from 2021 onwards is likely to increase ambition further to ensure that the policy instrument contributes to the EU 2050 target of a 80 to 95% reduction in GHG emissions below 1990 levels.

The EU ETS is widely acknowledged within the literature to have achieved abatement in a cost effective manner due to the creation of a price signal that reflects the supply and demand for allowances within the market (Section 3.2.2). However given the allowance surplus that has accumulated throughout Phase II, partly as a consequence of the economic recession, policy makers intervened via the backloading decision and by proposing future reforms such as the Market Stability Reserve to increase the flexibility of allowance supply to ensure that the dynamic efficiency of the EU ETS is improved to prevent the lock in of carbon intensive technologies. The importance of the EU ETS in delivering low cost abatement is demonstrated within various counterfactural simulations in the literature (Section 3.2.4). By improving the interaction between the EU ETS and complementary policies such as the RES Directive (Section 3.2.3) it is likely that the EU ETS will be able to contribute to the encouragement of the low-carbon technologies that the EU needs to transition to a decarbonised economy.

4. Gap analysis

Building upon the literature review in the previous section, the gap analysis takes a step back and provides a wider perspective on the availability of evaluations of the performance of the EU ETS. The methodological approach of the gap analysis is briefly summarised in Section 4.1 and is subsequently followed by a discussion of the main findings in Section 4.2 and a brief summary in Section 4.3.

4.1. Methodological approach

Within the review protocol an evaluation is defined as published primary research that applied a transparent and robust methodology in order to assess the performance of the EU ETS. Secondary research based upon a review of primary research is discounted from the gap analysis and therefore policy briefings, position statements, literature reviews, guidance and descriptive documents that were identified during the literature search were excluded. Furthermore research prior to 2005 was also excluded from the gap analysis. The literature included within the gap matrix table is intended to provide first insights into the availability of primary research on EU ETS performance (Table 9), however it is likely that information from research papers may not have been fully captured based upon the search terms applied in the literature search (which followed a strict methodology to limit selection bias).

In order to determine which aspects of the review questions require further research in the literature, a matrix table was developed, which enabled the review team to categorise the primary research according to 1) the sectoral and geographical scope 2) the content of the evaluation and 3) the methodology applied. The review protocol (Section 7.1) provides guidance on how to categorise the evaluations – especially for attributing the applicable broad categories (i.e. objectives, interaction, governance, functioning, short or long term impact) and evaluation criteria sub-fields to classify the content of each evaluation. Evaluations were often applicable to more than one broad category and evaluation criteria sub-field, therefore the review team were instructed in the review protocol to categorise evaluations to broad categories and evaluation criteria questions only if the outcome of the primary research was directly applicable. To ensure consistency, guidance was provided within the review protocol (Section 7.1).

Following the categorisation of the evaluations, gaps in the literature were identified based upon the following set of criteria:

- The conclusions of policy evaluations for a broad category and evaluation criteria sub-field were inconclusive referring to the literature review in the previous section;
- The range of policy evaluation methods applied for a particular broad category and evaluation sub-field may not be sufficiently varied or data availability was poor;
- The number of policy evaluations for a broad category and evaluation criteria sub-field was below a relative threshold (i.e. below the average);

4.2. Main findings

The outcome of the gap analysis is presented in Table 9 which illustrates the availability of evaluations on the performance of the EU ETS from the literature reviewed in this study. The findings from Table 9 will be discussed in the following sub-sections.

Table 9 Gap matrix table

Broad Categories	Objectives				Interaction				Governance				Functioning				Short term				Long term			
Sectoral Scope	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other	All	Power	Industry	Other
Geographical Scope																								
EU	2				18	6	1	2	25	3	1	1	86	32	18	6	34	20	39	1	21	16	27	2
Non-EU													2				1				1			
Evaluation Criteria																								
Relevance																								
Objectives vs needs	2																1				1			
Other													1											
Effectiveness																								
GHG abatement					4			1	4			1	13	2		1	18	5	1		6	1		1
Investment / innovation					2	2			4	2	1		6	4	2		9	9	8		12	13	10	
Competitiveness					1				2	1	1		4	3	3	1	8	7	23	1	7	5	15	1
Carbon leakage					1				3	1	1		8	1	4		10	2	23		6	1	16	
Other																								
Efficiency																								
Flexible mechanisms					4	1	1	1	5				19	2	3	2	7				3			
Transaction / admin costs					1				2				11		1		1				2			
Cap setting					2				4				11	1	2		6	1	1		1	1	2	
Allocation of allowances					3				8	1			33	10	8		15	5	4		5	3	3	
MRV									4				4		2		1				1			
Price signal					4	3	1	1	4				30	11	1	1	3	3			2	3		
Cost-pass through													3	15	7	2	1	1	3	1			1	1
Windfall profits					1				1				2	10	3	1	2		1		1			
Structural reform					1			1	4	1		1	18	1		2	6			1	2			2
Other									1				2		1									
EU Added Value																								
Alternative policies					5	1		1	8	2	1	1	3			1	2				5	2	1	1
Harmonisation									9				6				1							
Market oversight									3				2											
Other					1				9				4								1			
Coherence																								
Internal coherence					3				1				1											
External coherence					17	6	1	2	6	1		1	6	3	1	2	3			0	3	2		1
Other																								
Methodology																								
Theory based evaluation	1				3	1	1	1	4				7	4	1	1	2				2			
Econometric /statistical analysis					2				3	1	1		33	20	8		10	6	12		6	3	4	
Top down modelling					1	1	1	2	3			1	1	1	1	2	4	1	4		3	1	4	1
Bottom up modelling					7				5	2			8	10	2		3	7	12		2	6	10	
Multi criteria analysis					1				1				3				1				1			
Surveys									2				8		3	1	5		2		6		2	
Data analysis					4	3			7				27	6	3	2	12	5	12		4	4	9	
Interviews									2				2	3	4		1	3	7		2	3	6	
Event study	1																1				1			
Case Studies										1	1		3	1	2			2	1			3	2	
Legal analysis																			1				1	
Other					2	1			2				1		2	1	2		1	1	1			1

Note: Evaluations are categorised under multiple categories and therefore do not add up to the totals for each broad category under the sectoral and geographical scope.

Source: Own calculation

4.2.1. Effectiveness

Under the evaluation criteria effectiveness and the broad category of short term impacts, evaluations on GHG abatement were most prominent for all sectors of the economy (18 evaluations). While there was a consensus within the literature that abatement has been induced by the EU ETS, it was widely acknowledged that the construction of a counterfactual baseline was very uncertain – especially after the economic recession (Section 3.2.1). Evaluations on carbon leakage (23 evaluations) and competitiveness (23 evaluations) were most frequent in the industrial sector (Table 9). Although limited ex-post evidence of carbon leakage or competitiveness losses were found in the literature review (Section 3.2.1) it was generally accepted that the circumstances of Phase I and II would not necessarily be repeated in Phase III and beyond and therefore these concerns needed to be continuously evaluated assessed. The number of evaluations focusing on other sectors such as aviation and the potential inclusion of sectors currently outside the scope of the EU ETS (i.e. road transport) were more limited within the literature reviewed.

Under the evaluation criteria effectiveness and broad category of long term impacts, the evaluation criteria sub-field entitled investment and innovation (12 evaluations) accounted for the highest number of evaluations covering all sectors of the economy (Table 9). The research in this thematic area relates primarily to whether or not the EU ETS is successfully achieving the objective set to promote low-carbon technologies. The majority view from the literature reviewed was that while the EU ETS may have influence on small scale investment decisions (associated with short payback periods) and operational decisions – the influence of the policy instrument on the larger, longer term investment decisions (as outlined as an objective for the EU ETS in the 7th Environmental Action Plan) were limited as a consequence of the volatile and uncertain price signal.

The following gaps in the literature under effectiveness have been identified:

1. Counterfactual baselines without the EU ETS were associated with high levels of uncertainty and work is currently limited on baselines beyond Phase I. Future research needs to focus on the development of credible counterfactual baselines from which to assess the abatement driven by the EU ETS;

2. The review of the literature found several econometric analyses that aimed to quantify the impact of different drivers of emission reductions and competitiveness effects and this research needs to be replicated and improved upon as longer time series data becomes available;

3. Evaluations on carbon leakage via the investment channel (i.e. declines in inward investment) were limited and primarily based upon qualitative research techniques (i.e. surveys and interviews). Access to firm level data on investments would enable a more robust assessment of the vulnerability of industry to the risk of carbon leakage.

4. Based upon the literature reviewed, evaluations that focused on the effectiveness of sectors in past (i.e. aviation) and potentially future (i.e. road transport) scope changes to the EU ETS were more limited and warrants further analysis to better understand the impact on the overall effectiveness.

4.2.2. Efficiency

Under the evaluation criteria efficiency and broad category entitled functioning of the market, evaluations focusing on the allocation of allowances (33 evaluations covering all sectors of the economy) were frequently assessed in the literature. The allocation of allowances have wide implications for many design elements of the EU ETS – most notably for protectionist measures for sectors that are deemed to be at risk of carbon leakage. However intervening against this unintended impact had the further unintended effect of windfall profits in both the energy and industrial sectors as firms passed on the opportunity cost of allowances into consumer prices (Section 3.2.2). It is therefore possible to observe in Table 9 that evaluations that focus on allowance allocation are also often associated with short (15 evaluations covering all sectors of the economy) and long (5 evaluations covering all sectors of the economy) term impacts. Evaluations on the price signal of the EU ETS (30 evaluations covering all sectors of the economy) were prevalent in the literature. The majority of studies found that the EUA price is driven by market fundamentals and can therefore be considered as functioning efficiently. Evaluations on transaction costs (11 evaluations covering all sectors of the economy) were less frequent in the literature. However, evidence suggests that smaller firms are proportionately more affected by transaction costs than larger firms participating in the EU ETS. The following gaps in the literature under efficiency have been identified:

5. All in all it can be concluded that a correlation analysis aiming at singling out the effect of CO_2 pricing on product prices provides a major challenge. More robust insights might be gained by conducting more estimations based on similar assumptions and assessing the robustness of the results with the help of sensitivity analyses.

6. The dynamic efficiency of the EU ETS has emerged as an issue within the literature that warrants further investigation to determine whether or not the price signal of the EU ETS is strong and stable enough to promote the low-carbon technologies needed to lower the compliance costs of achieving ambitious GHG reduction targets in the long run.

7. Evaluations on transaction costs are mainly confined to qualitative evidence primarily at a national level with limited comparability between studies. More coordinated research at the national level is necessary to build up the evidence base and help to confirm the correct threshold for inclusion in the scheme.

4.2.3. Coherence

Under the evaluation criteria coherence and broad category of interaction, a growing body of research has emerged in the literature on the external coherence (17 evaluations covering all sectors of the economy) of the EU ETS with the RES and EE targets. The literature reviewed focused particularly on the interaction between the EU ETS and the RES Directive concluding that the interaction results in no additional emission reductions but reduces the price of EUAs (Section 3.2.3). The interaction between the EU ETS and the ESD was also evaluated within the literature where it was acknowledged by several authors that the over allocation of allowances in Phase I and II of the EU ETS increased the GHG reduction burden onto sectors covered by the ESD (i.e. buildings, transport) which has potentially increased the overall compliance cost of meeting the EU target for GHG reductions as marginal abatement costs in non-ETS sectors are widely accepted as being more expensive.

The following gaps in the literature have been identified :

8. Evaluations have concluded that the only way in which emission reductions from the RES Directive could be considered additional would be if the expected emissions were taken into account to further reduce the EU ETS cap. The extent to which the expected emission reductions from the 2030 target for renewable energy is coherent with the setting of the EU ETS cap requires further research.

9. The number of ex-ante and ex-post evaluations of the overlap of policy instruments is increasing in the literature to evaluate levels of overall coherence, however further research should also assess the potential impact of adding greater flexibility to the supply of allowances in the EU ETS via the introduction of the Market Stability Reserve as currently proposed by the European Commission.

10. Marginal abatement costs provide valuable data, from which to determine the most cost efficient split between sectors to reduce GHG emissions (and improve the coherence between the EU ETS and ESD). There is a need for greater collaboration between researchers to ensure that marginal abatement costs are accurate, transparently calculated and credible.

4.2.4. EU added value

Under the evaluation criteria EU added value and the broad category of governance, the literature reviewed is more limited. The main focus of the evaluations is on the added value of EU intervention regarding the implementation and enforcement of the EU ETS across all participating countries. There is evidence to suggest in Table 9 that the harmonisation of MRV and allocation rules has improved (9 evaluations under all sectors of the economy). However the functioning of the ETS compliance practice varies considerably across the different Member States as a result of different enforcement strategies, institutional settings and in funding. In light of a series of recent crimes related to the EU ETS several evaluations have qualitatively assessed the extent to which improvements in market oversight would prevent similar events taking place in the future. The EU added value is also assessed within the literature through the development of scenarios assessing the impact of alternative policies (8 evaluations under all sectors of the economy) such as carbon taxes and emission performance standards or simply no policies at all (Section 3.2.4). The majority of the studies evaluated show that emission reductions are achieved at lower cost by emissions trading than by alternative policies.

The following gaps in the literature have been identified :

11. Given the relatively low number of evaluations (relative to the average) under the evaluation sub-field entitled ‘market oversight’ further efforts should be made to assess the effectiveness of recent changes to market regulation to ascertain how resilient the EU ETS is to future criminal attacks.

12. The extension of free allocation provisions beyond 2020, which were announced by the European Council in October 2014, specified the need for ‘appropriate measures’ to protect the competitiveness of industry. Therefore further research into the design of harmonised benchmarking in Phase IV of the EU ETS is necessary.

13. Given the relatively low number of evaluations (relative to the average) under the evaluation sub-field entitled ‘alternative policies’ further efforts should be made to assess the alternative or possible complementary measures policies by developing credible and transparent counterfactual baselines.

4.2.5. Relevance

Under the evaluation criteria relevance and the broad category of objectives, the literature reviewed is very limited. However the relevance of the EU ETS in relation to the climate policy mix and market responses was evaluated within the literature. Furthermore, the majority of the research referred to the objectives of the EU ETS (and the needs of the EU) as a justification for examining key issues regarding the policy instrument.

The following gaps in the literature have been identified:

14. No evaluations within the literature reviewed that specifically assess the relevance of the EU ETS to the needs of the EU and therefore this could be an area for future research to provide further insights.

4.3. Summary

The outcome of the gap analysis is presented in Table 10, which shows the 14 evaluation gaps identified (which correspond to the numbered bullet points in the previous section) and are categorised according to the type of gap that include:

- *Methodological gap*: refers to limitations in the methodology currently deployed in the literature to assess the performance of the EU ETS;
- *Data gap*: refers to the limitation of data that prevents more quantitative approaches to assess the performance of the EU ETS from being implemented and;
- *Coverage gap*: refers to aspects of the EU ETS which are insufficiently covered in the literature reviewed.

Each of these different types of gap will be explained further in the following summary of the current gaps identified in the literature reviewed.

Table 10 Overview of the evaluation gaps identified in the literature

Evaluation Gap	Type of Gap
(1) Standardised counterfactual baselines need to be developed to evaluate EU ETS performance	Methodological
(2) Incomplete time-series data - research needs to be updated with more complete data	Data
(3) Lack of available data on investments	Data
(4) Limited evaluations on the past and future scope changes to the EU ETS	Coverage
(5) Sensitivity analysis of econometric results on cost pass through necessary	Methodological
(6) Dynamic efficiency of the EU ETS - is the price signal strong enough?	Coverage
(7) Lack of data availablity on transaction costs	Data
(8) Extent to which renewables development is accounted for in the 2030 EU ETS cap	Coverage
(9) Future impact of the Market Stability Reserve on the functioning of the EU ETS	Coverage
(10) Standardised, credible and transparently calculated marginal abatement costs curves	Methodological
(11) Limited evaluations on market oversight	Coverage
(12) Future allocation of free allowances - defining 'appropriate measures'	Coverage
(13) Limited evaluations on alternative policies to EU ETS	Coverage
(14) Limited evaluations assessing the relevance of the objectives to the needs of the EU	Coverage

Source: Own calculation

4.3.1. Methodological gaps

The development of counterfactual baselines in order to assess the performance of the EU ETS, should be a priority for future research. For example, evaluations on the GHG abatement induced by the EU ETS (Section 3.2.1) were limited by how the counterfactual baseline (i.e. emissions development without the EU ETS) was constructed. The availability of emissions data at the necessary level of disaggregation also hindered efforts to assess the impact of the EU ETS on GHG abatement – especially with Phase I evaluations. The economic shock at the start of Phase II further increased the difficulty of developing a credible counterfactual baseline, with projections of GHG emissions in Phase II, often based upon common drivers (i.e. GDP growth, energy intensity development), invalidated by the size of the economic recession. As a consequence, econometric techniques have been increasingly deployed in the literature to identify the drivers of GHG abatement in Phase II – which will provide important insights for future counterfactual baseline development. Further collaboration between researchers, public authorities and consultants is required in order to have standardised baselines that are widely accepted from which future evaluations on the effectiveness of the EU ETS can be completed.

The lack of agreement between ex-ante modelling and empirical ex-post assessments in the literature regarding carbon leakage suggests that the modelling assumptions used in ex-ante studies, such as the carbon price and estimates of cost pass through, may not accurately reflect the reality observed so far in Phase I and II of the EU ETS. This is to a certain extent inevitable as modelling assumptions were made with expectations that did not materialise as a consequence of unanticipated events. Although the disparity between ex-ante modelling and empirical ex-post assessments may also have been due to the implementation of carbon leakage provisions (i.e. allocation of free allowances) that may have prevented the more pessimistic ex-ante modelling results from taking place. Given the reforms to the EU ETS in Phase III, it will be important for future research to accurately consider the impacts of measures, such as allocating free allowances via benchmarking, by updating modelling assumptions to take into account recent developments. In order to improve the comparability of ex-ante modelling results in the future it may be helpful for certain standard assumptions to be commonly adopted by researchers.

4.3.2. Data gaps

The lack of investment data limits the ability of researchers to currently answer questions regarding issues such as carbon leakage via the ‘investment channel’ and therefore the methodologies applied are also limited to more qualitative approaches. For example, currently survey data is primarily relied upon to ascertain the influence of the EU ETS on investment decisions. Although survey data provides interesting insights the outcome of the research may not necessarily be widely applicable to all firms participating in the EU ETS. Confidentiality concerns will always hinder the accessibility of investment data. However improvements need to be made, even at a more aggregated level, in order to ascertain the impact of the EU ETS on the investment decisions. Improving data availability via more comprehensive company reporting may eventually allow for more quantitative techniques to be applied in the future.

Given that Phase I of the EU ETS only started in 2005, the empirical evidence base for evaluating the performance of the EU ETS has been relatively limited compared to other more mature markets. However, now that data is available for two complete phases of the EU ETS it should be a priority for researchers to replicate previous methodologies from the literature with updated time series data in order to see if the original findings remain valid. For example, econometric studies that evaluated the ability of firms to pass through carbon costs into prices or assess their level of competitiveness would benefit from longer time series data to improve the significance of previous results.

4.3.3. Coverage gaps

The European Council Conclusions in October 2014 reaffirmed that the EU ETS is the main European instrument to achieve the EU's 40% GHG reduction target, however the text emphasised that reform is necessary to ensure that the ETS functions correctly. Based upon the review of the literature, the number of robust evaluations on the impact of the Market Stability Reserve remains relatively low. However, this is to be expected given the fact that the proposal for the policy intervention is very recent and further research on its impacts on the EUA price and allowance surplus is expected. The concerns of industry regarding carbon leakage were alleviated slightly with the announcement in the European Council Conclusions that the provision of free allowances to protect sectors deemed at risk of carbon leakage will continue after 2020. The debate now turns to what constitutes 'appropriate' levels of support. Within the literature, evaluations focusing on benchmarking and alternatives to free allocation (i.e. dynamic allocation) were relatively low in number. This is another area to be further addressed in future research.

In addition to coverage gaps as a consequence of new policy decisions regarding the EU ETS, it was evident from the gap analysis that certain sub-fields associated with 'older' issues received relatively less attention. These included evaluations focusing on market oversight, on the internal coherence of the EU ETS and on other sectors such as aviation and sectors that may be included in the EU ETS in future scope extensions (i.e. road transport). These gaps may reflect a lack of activity in the literature. However, this result may also be due to the limitations of the literature review search. Although over a 1000 publications were considered for the literature review, it is likely that certain publications may have failed to be detected and therefore this research should be continually updated over time to build upon the literature collected in this project. A systematic approach was undertaken to search for publications to include in the review without bias. However, it is likely that the selection of search terms and the categorisation of evaluations in the gap analysis may be subject to a certain degree of bias – therefore the approach is transparently documented in order to reduce any selection bias in future work.

5. Conclusion

The EU ETS is associated with multiple objectives, which have developed over time, and correspond to the needs of the EU to reduce GHG emissions. The literature on the performance of the EU ETS has been reviewed in accordance with five evaluation criteria (effectiveness, efficiency, coherence, EU added value and relevance) all of which were associated with specific review questions. The study responded to each of these questions based upon the findings of the literature review, which provided stronger evidence for certain aspects of the EU ETS performance (i.e. over allocation of allowances) compared to less reliable evidence for other aspects (i.e. investment leakage caused by the EU ETS). This report then attempted to quantify such insights further by constructing a gap matrix table, which was the product of a detailed review of over 250 publications (which were screened from an initial search of over 1000 publications from a range of sources). By extracting data from these publications, the gap matrix table was populated with information to enable gaps in the literature to be identified for further research. In total, fourteen gaps were identified that were categorised into methodological, data and coverage gaps.

The results of this study can contribute to learning from previous experiences with the EU ETS in view of seizing the EU ETS' potential to make an important contribution to achieve the 2030 GHG reduction target confirmed recently by the European Council. The evaluation of the performance of the EU ETS needs to be improved upon, in particular in order to identify and better address areas where the functioning of the EU ETS could be improved.

Firstly, the study has identified important methodological gaps that exist in the construction of credible baselines from which to assess the impact of the EU ETS on GHG abatement, competitiveness etc. It therefore should be a priority to encourage greater collaboration amongst researchers to ensure that these counterfactual baselines become more standardised and widely agreed upon in the future to enhance the comparability between evaluations.

Secondly, data gaps identified in the literature will need to be addressed if important questions concerning the performance of the EU ETS, especially with regards to investment leakage, are to be definitively answered in the future.

Thirdly, coverage gaps in the literature mainly relate to the emergence of new topics as the EU ETS enters a period of reform. It is evident that further clarity will be required to ascertain whether additional complementary policies (i.e. emission performance standards) are necessary to improve the dynamic efficiency of the scheme and create a strong and stable price signal to promote the low-carbon technologies necessary to deliver the most ambitious emission reductions targeted in 2050. The proposal by the European Commission to introduce greater flexibility in managing the supply of allowances in the EU ETS, should help to alleviate previous problems experienced with economic shocks and overlapping policies. However, this will need to be validated by future research. The extension of carbon leakage provisions beyond 2020 (as announced in the European Council Conclusions in October, 2014) and benchmarking provisions for free allocation in Phase IV will be another important area of research.

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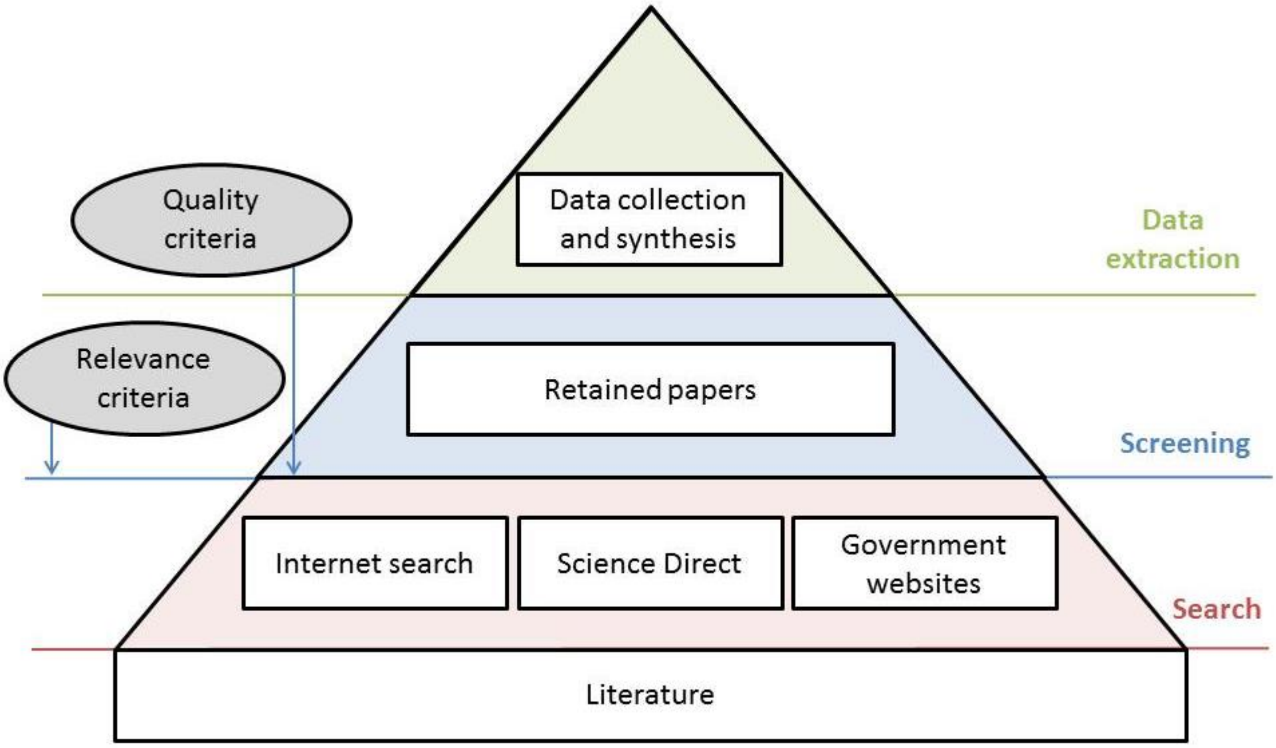
7. Annex

7.1. Review Protocol

7.1.1. Overview

A lead reviewer will be assigned to oversee the process of searching for literature references within a small team of experts, which will be formed before the establishment of a review protocol to allow all members of the team to contribute to its' development. All review team members will actively contribute to the design of a review protocol, which will provide the reference point on how each member of the team will conduct the search for literature references. The review protocol will include the elements illustrated in Figure 7, which will be outlined in more detail in the following sub-sections.

Figure 7 Stages of the review protocol



Source: Own illustration

7.1.2. Literature search

The approach for searching the literature is clearly outlined in the bullet points below so that it can be easily replicated by all members of the review team. The search of the literature will focus on the following sources as a priority:

- Firstly searching a list of government websites for international countries with active GHG emission trading schemes to review policy evaluations with relevance to the EU ETS;
- Secondly searching a list of government websites for countries participating in the EU ETS to review policy evaluations;
- Thirdly to complement the information provided by Member States, databases will also be searched (i.e. Science Direct), internet searches conducted and browsing the websites of specific research institutes with emissions trading expertise using the following twenty search terms (Table 11);

The literature search via the internet and science direct will be limited to publications from 2005 onwards that specifically refer to the trading periods of the EU ETS.

Table 11 Search terms for literature review

Relevance	EU ETS + relevance EU ETS + objectives
Effectiveness	EU ETS + effectiveness EU ETS + GHG abatement EU ETS + competitiveness EU ETS + carbon leakage EU ETS + cost pass through EU ETS + low carbon technology EU ETS + investments
Efficiency	EU ETS + efficiency EU ETS + governance EU ETS + functioning EU ETS + behaviour EU ETS + transaction costs EU ETS + benchmarking EU ETS + MRV EU ETS + MSR EU ETS + flexible mechanisms
EU added value	EU ETS + alternative measures
Coherence	EU ETS + interaction

Source: Own illustration

7.1.3. Screening criteria

The logic underpinning the inclusion or exclusion of a particular study will be outlined in this section of the review protocol. The evaluations will be based upon relevance and quality criteria that are outlined below:

Relevance criteria

- Analyses the extent to which the EU ETS meets the objectives of the policy intervention
- Analyses the coherence of the EU ETS

- Analyses the interaction between the EU ETS and other EU policies
- Analyses the impact of reforms to the EU ETS
- Analyses the implementation of the EU ETS (i.e. transaction costs, price signal)
- Analyses the governance of the EU ETS
- Analyses the allocation of allowances in the EU ETS
- Analyses the counterfactual situation (i.e. impacts with no EU ETS)
- Analyses cost effectiveness of the EU ETS compared to alternative policy instruments
- Analyses the impact of the EU ETS on GHG abatement
- Analyses the impact of the EU ETS on competitiveness and carbon leakage
- Analyses the extent to which the EU ETS has promoted low-carbon investments
- Analyses the influence of EU ETS towards a transition to more sustainable systems
- Relevant to elements of the EU ETS (if GHG emission trading scheme outside EU)

Quality criteria

- Published primary research that is data / evidence driven
- Transparent and robust methodology
- Reflects different evaluations types
- Academic papers
- Discussion papers
- Not opinion piece

7.1.4. Data extraction

Each member of the team will firstly input key information (i.e. title, author, date etc.) from the studies reviewed into a data entry worksheet (Figure 8). Each reviewer will be required to categorise each study according to which broad category, evaluation criteria and methodology are most applicable. The following provides guidance on how to categorise the studies retained following the screening process.

Broad category and evaluation criteria

When the methodology of an evaluation directly addresses a sub-field in the evaluation criteria it is necessary to link to the relevant broad category. It is possible for one methodology to address several of the evaluation sub-fields and alternatively it is possible for an evaluation to adopt several methodologies. The link between broad category and evaluation criteria is illustrated in Figure 9 and is outlined in the following:

- **Objectives** (relates to sub-fields under *relevance*)

Objectives vs needs: Evaluations directly assessing whether the objectives of the EU ETS corresponds to the needs of the EU

Other: Evaluations directly assessing the relevance of the EU ETS in general

- **Interaction** (relates to sub-fields under *coherence*)

Internal coherence: Evaluations directly assessing the coherence of the different design elements of the EU ETS

External coherence: Evaluations directly assessing the coherence of the EU ETS with external policies (i.e. Effort Sharing Directive, Renewable and Energy Efficiency Directives)

Other: Evaluations directly assessing other aspects of coherence

- **Governance** (relates to sub-fields under *EU added value*)

Alternative policies: Evaluations directly assessing the impact of alternative policies to achieve the objectives of the EU ETS (i.e. carbon taxes, emission standards)

Harmonisation: Evaluations directly assessing the impact of harmonising different design elements of the EU ETS (i.e. registry, allocation rules etc.)

Market oversight: Evaluations directly assessing market oversight provisions under the EU ETS.

Other: Evaluations directly assessing other aspects of EU added value

- **Functioning of the market** (relates to sub-fields under *efficiency*)

Flexible Mechanisms: Evaluations directly assessing the use of flexible mechanisms to comply with the EU ETS

Transaction / Admin costs: Evaluations directly assessing the transaction and administrative costs associated with the EU ETS

Cap Setting: Evaluations directly assessing the impact of the cap on the efficiency of the EU ETS

Allocation of allowances: Evaluations directly assessing the impact of the allocation method on the functioning of the EU ETS (may relate to carbon leakage, cost pass through, windfall profits etc.)

MRV: Evaluations directly assessing MRV provisions within the EU ETS

Price Signal: Evaluations directly assessing whether or not the price signal is driven by market fundamentals or assesses future EUA prices

Cost Pass Through: Evaluations directly assessing whether carbon costs are passed through to product prices

Windfall profits: Evaluations directly quantifying the profits that results from carbon cost pass through

Structural reform: Evaluations directly assessing the impact of reform on the functioning of the market

Other: Evaluations directly assessing other aspects of efficiency

- **Short term impacts** (relates to sub-fields under *effectiveness*)

GHG abatement: Evaluations directly assessing whether GHG abatement has taken place as a consequence of the EU ETS

Investment / Innovation: Evaluations directly assessing whether investment and innovation has been promoted by the EU ETS

Competitiveness: Evaluations directly assessing whether competitiveness has been impacted by the EU ETS

Carbon Leakage: Evaluations directly assessing whether carbon leakage has occurred from the different channels of leakage

Other: Evaluations directly assessing other aspects of effectiveness

- **Long term impacts** (relates to sub-fields under *effectiveness*)

GHG abatement: Evaluations directly assessing whether GHG abatement will take place as a consequence of the EU ETS

Investment / Innovation: Evaluations directly assessing whether investment and innovation will be promoted by the EU ETS

Competitiveness: Evaluations directly assessing whether competitiveness will be impacted by the EU ETS

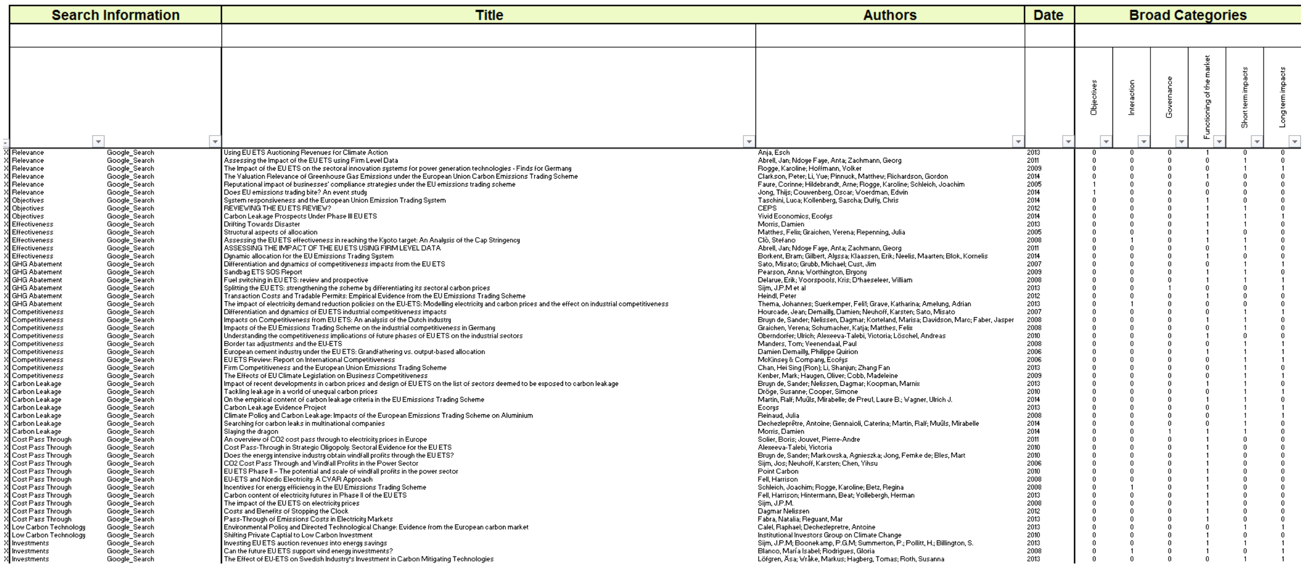
Carbon Leakage: Evaluations directly assessing whether carbon leakage will occur from the different channels of leakage

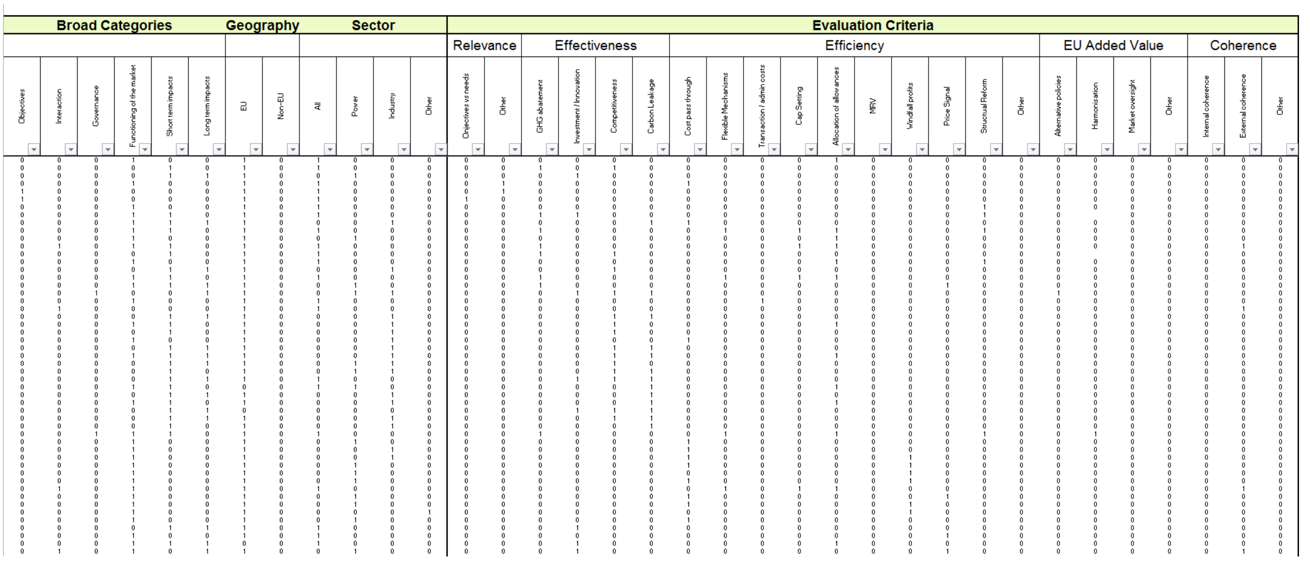
Other: Evaluations directly assessing other aspects of effectiveness

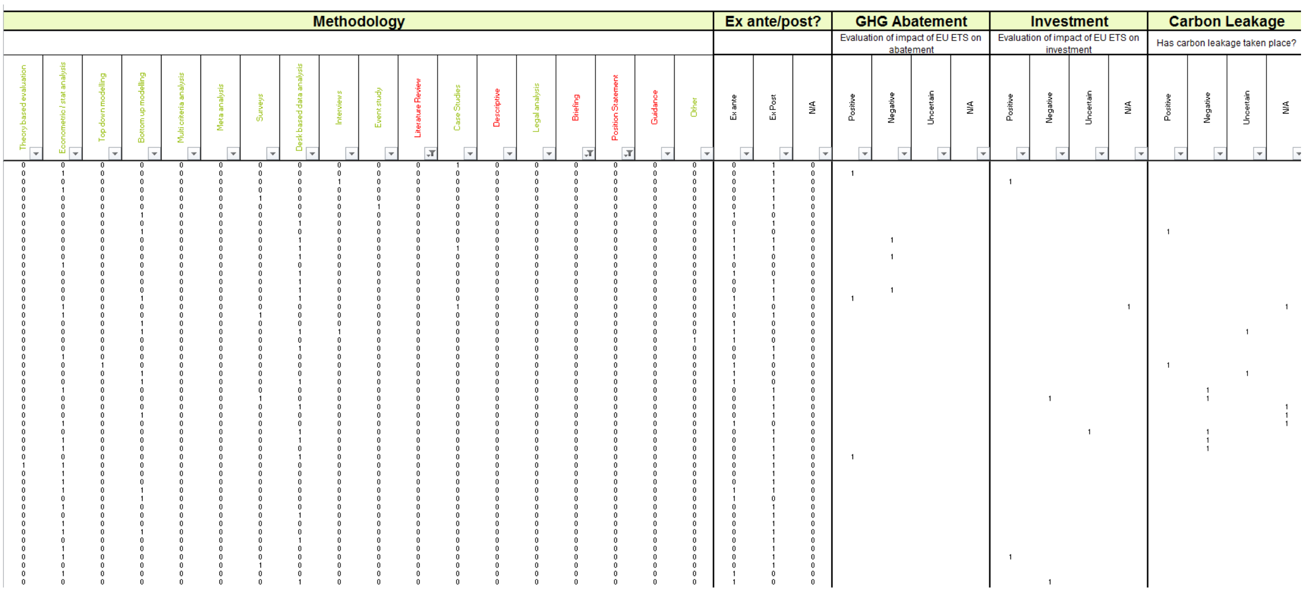
Methodology:

The categorisation of methodologies are relatively self explanatory, however it is important to categorise briefings as research papers without a transparent and robust methodology that only present the arguments of the author. Data analysis refers to more simple calculations using large data sets to respond to an evaluation question.

Figure 8 Screenshots of data entry worksheet for literature review & gap analysis







Source: Öko Institut (2014)

Figure 9 Guidance for categorising evaluations in the gap matrix table

Broad Categories	Objectives	Interaction	Governance	Functioning of market	Short term impacts	Long term impacts
Sectoral Scope	All, Power, Industry, Other	All, Power, Industry, Other	All, Power, Industry, Other	All, Power, Industry, Other	All, Power, Industry, Other	All, Power, Industry, Other
Geographical Scope EU Non-EU	Categorise evaluations according to sectoral and geographical scope					
Evaluation Criteria						
Relevance Objectives vs needs Other	Relevance					
Effectiveness GHG abatement Investment / innovation Competitiveness Carbon leakage Other					Short term impacts	Long term impacts
Efficiency Offsetting Transaction / admin costs Cap setting Allocation of allowances MRV Price signal Structual reform Cost-pass through Windfall profits Other				Functioning of market		
EU Added Value Alternative policies Harmonisation Market oversight Other			Governance			
Coherence Internal coherence External coherence Other		Interactions				
Methodology Theory based evaluation Econometric /statistical analysis Top down modelling Bottom up modelling Multi criteria analysis Meta analysis Surveys Data analysis Interviews Event study Case Studies Other	Categorise evaluations according to methodology applied					

Source: Own illustration