Dialogue on a RES policy framework for 2030

towards2030

The evolving EU ETS carbon price

- Issue paper for the Towards2030 project

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About the project

The aim of **towards2030-*dialogue*** is to facilitate and guide the RES policy dialogue for the period towards 2030. This strategic initiative aims for an intense stakeholder dialogue that establishes a European vision of a joint future RES policy framework.

The dialogue process will be coupled with in-depth and continuous analysis of relevant topics that include RES in all energy sectors but with more detailed analyses for renewable electricity. The work will be based on results from the IEE project beyond 2020 (www.res-policy-beyond2020.eu), where policy pathways with different degrees of harmonisation have been analysed for the post 2020 period. **towards2030-*dialogue*** will directly build on these outcomes: complement, adapt and extend the assessment to the evolving policy process in Europe. The added value of **towards2030-*dialogue*** includes the analysis of alternative policy pathways for 2030, such as the (partial) opening of national support schemes, the clustering of regional support schemes as well as options to coordinate and align national schemes. Additionally, this project offers also an impact assessment of different target setting options for 2030, discussing advanced concepts for related effort sharing.

Who we are?

Vienna University of Technology, Energy Economics Group (EEG), Austria *(Project coordinator)*
Fraunhofer Institute for Systems- and Innovations Research (Fraunhofer ISI), Germany
Energy Research Centre of the Netherlands (ECN), Netherlands
Center for European Policy Studies (CEPS), Belgium
National Technical University of Athens (NTUA), Greece
Consejo Superior de Investigaciones Cientificas (CSIC), Spain
Ecofys Netherlands and affiliates (Ecofys), Netherlands
REKK Energiapiaci Tanacsado Ltd (REKK ET), Hungary
European University Institute, Florence School of Regulation (EUI), Italy

Table of contents

Figures

Tables

1. Introduction

Greenhouse gas emissions cause damages that are, absent regulatory intervention, not reflected in market prices giving rise to the large-scale market failure that is at the heart of the economics of climate change (Stern 2007).

It is a well-understood economic prescription to put a price on such negative externalities to enable producers and consumers throughout the economy to internalize the associated social costs in their private decision-making. Another important function of a carbon price is to set an incentive for developing and introducing low-carbon products and processes to replace existing technologies (Edenhofer et al 2009).

The emissions trading scheme (ETS) is arguably the flagship of the climate program in the EU and the most relevant climate policy initiative in the world. Carbon prices from this scheme are expected to induce substitution of cleaner for dirtier energy sources and lead to an effective decarbonisation of the energy and the production system.

The price signal is, thus, a main element in the decarbonisation strategy of the EU. However, as a quantity-based climate policy instrument, the level and trends in carbon prices are difficult to know a priori. There is significant uncertainty over future carbon prices. This hinge critically on (1) innovation and the availability of low-carbon alternatives to conventional fossil fuels, (2) flexibility of substituting emissions-intensive activities in the energy-economic system, and (3) the ability of policy-makers to stabilize investors' confidence via credibly committing to long-term carbon pricing regimes (Edenhofer et al 2009). Notwithstanding, caps and floors on carbon prices can contribute to investors' confidence (see, e.g., Richstein 2014). These authors find out that a common, moderate CO2 auction reserve price results in a more continuous decarbonisation pathway. This reduces CO2 price volatility and the occurrence of carbon shortage price periods, as well as the average cost to consumers. A price ceiling can shield consumers from extreme price shocks. These price restrictions do not cause a large risk of an overall emissions overshoot in the long run. A national price floor lowers the cost to consumers in the other zone; the larger the zone with the price floor, the stronger the effect. Price floors that are too high lead to inefficiencies in investment choices and to higher consumer costs.

The aim of this issue paper is to identify plausible carbon prices in the EU ETS in the short and medium term (2020 and 2030) using different information sources. Accordingly, this paper is structured as follows. The next section describes the methodology and the data sources. Section 3 provides the main results. The issue paper closes with a discussion of those results.

2. Methodology

Identifying possible carbon prices in the future, whether in the short or medium terms, is quite a difficult exercise. The reason is that it depends on many variables, some related to policy design, some related to the general situation of the economy, including GDP growth and changes in electricity demand. Relying on only one source cannot be recommended, since they can be regarded as complementary and can provide different insights on the problem. No single source can be deemed a perfect one and, thus, taking into account different perspectives can be very useful to provide ranges of prices which can be considered plausible.

Therefore, we rely on four different sources of information:

I) *Expert surveys*. Several surveys which provide rich information on several aspects related to climate policy, including carbon prices, have been published. These include Point Carbon (2015) and IETA (2015). These are based on the expectations of professionals involved directly or indirectly in the carbon market.

II) *Endogenous results from models*. In addition, climate-energy-economy models may provide relevant information on carbon prices, which would be an endogenous result from the interactions of several variables in those models.

III) *Input in models*. Finally, some models may introduce the carbon price as an exogenous variable, maybe as a result of expert surveys or another method. This information can also be valuable.

IV) *Forward prices*. Current market information, e.g. on forward prices, provides some valuable information on future carbon prices.

3. Main results

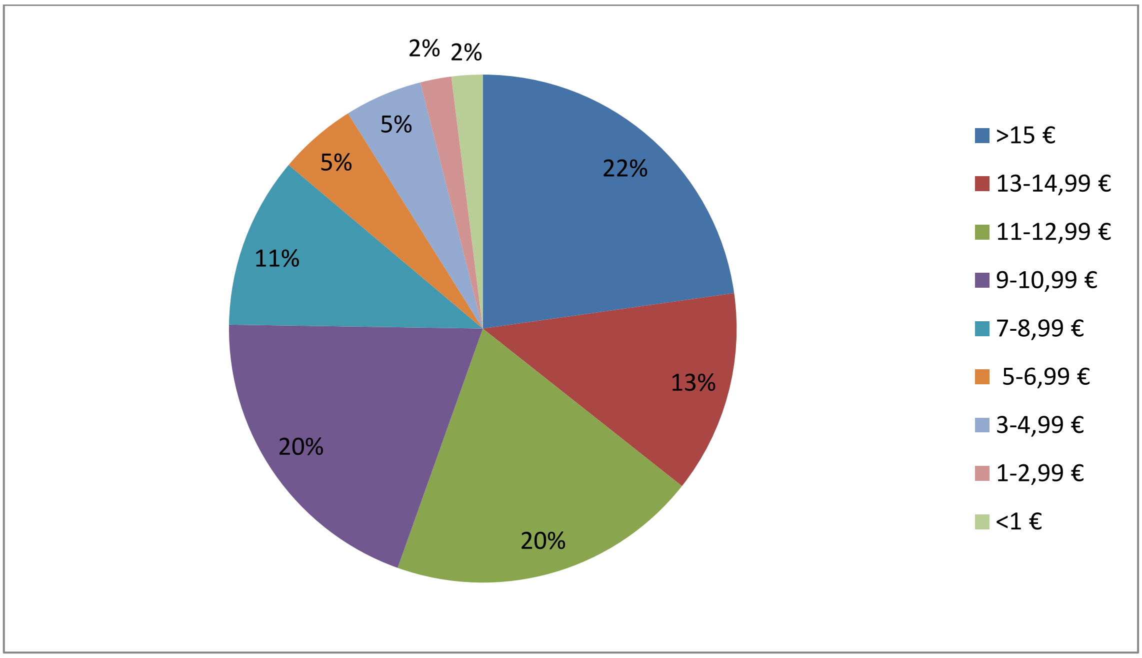
3.1. Carbon prices according to surveys

Different surveys based on expert elicitations show CO2 price forecasts. The Point Carbon survey developed by Thomson Reuters is probably the most well-known although it is not the only one. The IETA GHG Market Sentiment Survey carried out by PwC is also an important source for expert opinions on CO2 price expectations. These two sources will be used in this section. Although they are not based exactly on stakeholder's opinions but on analysts' predictions two other sources are considered relevant in this context: the Carbon Pulse Survey and Synapse Energy Economics Survey.

3.1.1. Point Carbon Survey

The tenth Point Carbon annual survey (2015) covers a wide range of carbon markets: the EU ETS, Western Climate Initiative (WCI), Regional Greenhouse Gas Initiative (RGGI), the Chinese pilot markets, South Korea, Kazakhstan, New Zealand, Clean development mechanism (CDM) and Joint implementation mechanism (JI). In this wave, a total of 1203 experts including carbon traders, emitting companies, government workers, public decision makers and researchers, among others, were contacted. The size of the sample varies among different markets with the largest being the EU ETS with 602 respondents.

Based on the results of this survey, expert elicitations on carbon prices are shown in the following figure. Because of a lack of representativeness in the expert sample size, Point Carbon provides 2020 carbon price expectations only for the EU ETS. Unfortunately, there is no question on the expected price of European Union Allowances (EUAs) in 2030.



Source: Point Carbon (2015). Note: No-answer responses are not included. N=457.

Figure 1 **EUAs price expectations in 2020**

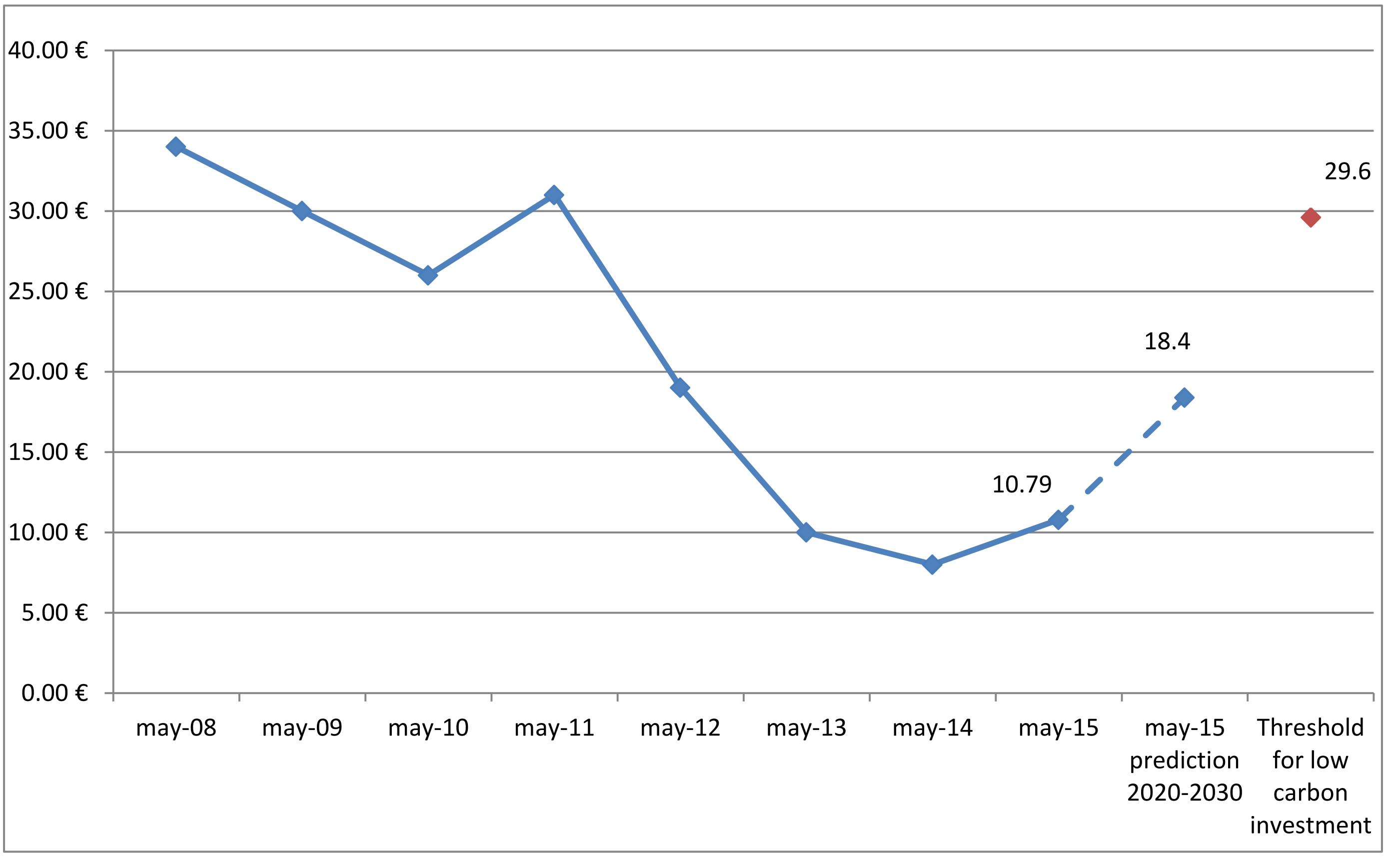
Based on the previous results, price expectations for 2020 appear to be quite atomized. However, 75% of the sample predict a CO2 price over 9 € with almost 25% forecasting a price over 15 €. This expectation is more than double the current price of EUAs[1].

3.1.2. IETA GHG Market Sentiment Survey

The IETA GHG Market Sentiment Survey is carried out by PricewaterhouseCoopers (PWC) with a sample of 122 International Emission Trading Association (IETA) member representatives that, as it is also the case in the Point Carbon survey, covers a wide range of organization types but with a clear interest in European and North American carbon markets.

As can be seen from the results of the survey (figure 2), IETA experts expect slightly higher EUA prices than those responding the Point Carbon survey.

[1]EUA average price in CO2 spot market in 2015 has been 7,17 €



Source: IETA GHG Market Sentiment Survey (2015)

Figure 2 **Average EUAs price expectations in IETA surveys (2008-2015) for phase III**

Since 2011, expert elicitations in the IETA survey have shown a continuous drop in CO2 prices. In the last wave of the survey (May 2015), EU ETS price expectation for the last phase (2013-2020) is 10.8 €. This figure rises to 18.4 € when considering the period 2020-2030. One of the most relevant results shown by this survey is related to how much the carbon price should be in order to drive low carbon investments (29.6 €).

3.1.3. Carbon Pulse survey

In July 2015 Carbon Pulse, an online service dedicated to providing in-depth news and intelligence about carbon pricing initiatives and climate change policies, carried out a survey among 11 market analysts[2]. Analysts predict an average price at the end of phase III close to 13 € (12.80 €), which is within the range of the aforementioned surveys. However, Carbon Pulse highlights that this is 11% lower than predictions in the previous wave of the survey[3]. This result then contrasts with the trend shown in the IETA's survey where the last wave gave upward predictions.

The following table the individual predictions of EUA prices for the six years remaining of the third phase from Carbon Pulse.

Table 1 Analysts' predictions of CO2 prices (€)

	End 2015	End 2016	End 2017	End 2018	End 2019	End 2020
BNEF	10,00	N/A	14,00	N/A	N/A	30,00
Commerzbank	9,00	9,50	N/A	N/A	N/A	N/A
Consus	7,42	7,50	8,05	8,50	9,32	10,58
Energy Aspects	7,80	10,50	14,00	14,00	18,00	21,00
ICIS-Tschach	10,00	14,00	N/A	N/A	N/A	N/A
Markedskraft	7,00	N/A	N/A	N/A	N/A	N/A
Nomisma Energia	8,10	9,00	9,75	11,20	12,00	14,40
Point Carbon	8,90	11,40	13,50	15,60	16,70	17,70
Societe Generale	8,32	8,49	8,71	8,98	9,29	9,64
Vertis	8,50	N/A	N/A	N/A	N/A	N/A
Virtuse	8,50	9,00	9,30	10,00	11,50	14,50
Average	**8,50**	**9,90**	**11,05**	**11,40**	**12,80**	**16,85**
Median	**8,50**	**9,25**	**9,75**	**10,60**	**11,75**	**14,50**
Average price	8,90	10,80	11,00	11,60	14,40	16,80
% change	-4,5%	-8,3%	0,5%	-1,7%	-11,1%	0,3%

Source: Carbon Pulse (2015).

[2] For further information see http://carbon-pulse.com/
[3] Previous wave took place on April 2015 and included only 10 analysts.

From the data shown in table 1 we can conclude that the dispersion of the results is large. It varies from a minimum of 9.6 € for Societè Generale to a maximum of 30 € for BNEF. On average, the prediction for 2020 is 16.8 €, much higher than 10.8 €, which is the value expected for the IETA representatives.

3.1.4. Summary of CO2 price predictions

In this section we bring together the expert expectations from the range of different sources and CO2 markets, to provide some guidance on future carbon prices. From table 2, it can be conclude that, although for some sources experts show divergent opinions, on average price expectations are close to each other among surveys.

Table 2 Summary of expert elicitations on CO2 EU ETS prices

	2020	2030
Point Carbon	> 9 € (23% >15€)	---
IETA	10.8 €	18.4 €
Carbon Pulse	9.6 € to 30 €	---

Source: Own elaboration.

3.2. Endogenous predictions in climate-energy-economy models

Climate-energy-economy models represent a fundamental tool to evaluate mitigation strategies and assess their economic costs. These models include a representation of socio-economic processes, such as economic growth and the dynamics of consumption and investment. Energy is usually regarded as a production factor, alongside capital and labor. To link energy use to climate impacts, carbon emissions from the combustion of fossil fuels are computed and their effects on atmospheric concentrations and temperatures are assessed using a coupled climate module. To account for the fact that climate change is a global and long-term challenge, climate-energy-economy models are required to represent the entire world economy and carry out simulations over a long period (sometimes even a century). A global model is preferable over a regional one if used to forecast carbon prices, since at least two factors having a strong impact on the carbon price are global: fossil fuel prices and technology costs (learning effects)[4].

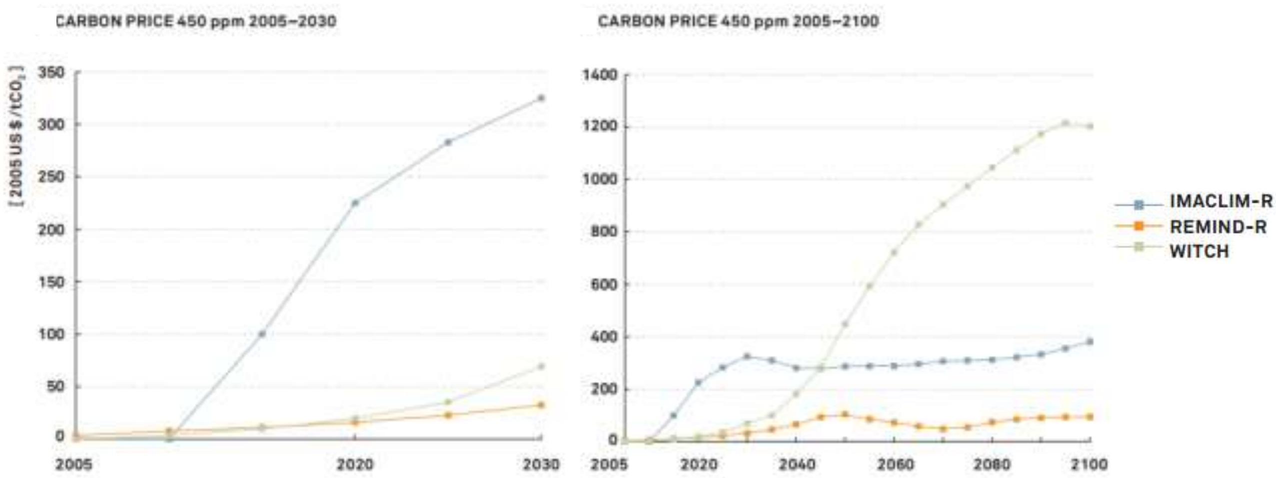
This integrated view permits establishing plausible and self-consistent scenarios on how the world will develop if business-as-usual is continued or climate policies are adopted. Climate policy scenarios provide information about optimal emission trajectories, carbon prices, economic costs of GHG mitigation and their distribution across regions, and about possible energy futures with regards to energy sources and energy technologies. To keep the analysis tractable, models have to abstract from reality and represent economic sectors and technologies in a simplified way. Hence, climate-energy economy models are best suited for the analysis of long-term stabilization strategies rather than providing very detailed descriptions of short-term impacts of climate policies.

Notwithstanding – owing to the complexity and uncertainties related to the issue under study – the model results should be interpreted as scenarios rather than accurate forecasts of future developments of carbon prices. Different models may generate very different sets of scenarios, depending on the view of the world they represent regarding e. g. assumptions on future technological developments in the energy sector, inertia in the deployment of new technologies, and how economic agents form expectations (Edenhofer et al 2009, p.15).

As mentioned in the introduction, carbon prices in these models depend critically on assumptions about (1) innovation and the availability of low-carbon alternatives to conventional fossil fuels, (2) flexibility of substitution within the energy-economic system, (3) the ability of policy-makers to stabilize investors' confidence in the carbon market and (4) the immediate action of major emitters (Edenhofer et al 2009). In addition, the evolution of total energy consumption influences the demand for

[4] If a regional model is used, it has to use exogenous assumptions on these two. This is the case e.g. in case of Primes, where e.g. the fossil price assumption comes either from Poles, Prometheus or from other global models.

allowances and, thus, the carbon price. Three of these models are IMACLIM (Waisman et al 2012), REMIND-R (Leimbach et al 2010) and WITCH (Ciao et al 2012). The RECIPE project compared the carbon prices from these three models, with two different timeframes: 2030 and 2100. The following figure shows the respective carbon prices. But it is also related to different assumptions about the existence and costs of back-stop technologies, which may limit the maximum price of carbon. Furthermore, carbon prices are calculated using a different method in the models. Some of the models assume 'efficient' carbon pricing in the sense, that the long term carbon value path should follow an exponential growth curve if a certain target is to be met (derived from the Hotelling rule) So the equilibrium carbon value would monotonously increase over time in the whole modelled period. In these solutions you cannot really observe price fluctuations, as the optimal path is derived. Other models will search for equilibrium carbon value within a year (or other time interval), so it would show higher volatility, depending on the technological developments, or on other factors (energy demand growth).



Source: Edenhofer et al (2009).

Figure 3 **Evolution of carbon price in the EU in a 2030 and 2100 timeframes**

It can be observed that the range of prices both in 2030 and 2100 is very wide. Although all the models predict an increase in those prices, the growth rate significantly differs across them. This is related to the differences in model approaches.

In IMACLIM-R, due to the assumptions on imperfect foresight, very high carbon prices are required initially to create a sufficiently strong signal to trigger a transition to a low-carbon energy system. The flat profile of the carbon price in IMACLIM-R after 2030 can be attributed to (1) the learning processes in carbon saving energy technologies that increase the reduction potentials available at a given carbon price and by (2) climate-friendly infrastructure policies that avoid a costly lock-in to carbon-intensive transportation systems, thus removing a critical obstacle to stabilization in the long run.

REMIND-R and WITCH, by contrast, are perfect foresight intertemporal optimization models and therefore envisage smoother development of the carbon price and almost steady increases until the middle of the 21st century. In REMIND-R, the carbon price is projected to remain on a moderate level. Learning processes reduce the cost of low-carbon technologies, most notably renewables. The availability of cheap alternative energy sources reduces CO2 abatement costs and allows focusing the mitigation effort on decarbonization, while the reduction of energy demand plays a less important role. After the concentration target of 450 ppm is reached, CO2 emissions remain stable. Therefore, REMIND-R projects both the carbon price and mitigation costs to peak in the middle of the century and decrease afterwards when the effect of technological learning becomes stronger.

Different carbon price trajectories across the three models reflect the general uncertainty about CO2 prices. Model assumptions on macro-economic flexibilities, the nature of the decision process (perfect foresight vs. imperfect foresight), and the availability and cost of low-carbon technologies have a strong impact on the simulated carbon price level. Similarly, real-world carbon prices will depend strongly on (1) a stringent yet flexible global framework for achieving deep emission reductions, (2) the ability of policy makers to establish credible expectations of short, medium and long term reduction targets, (3) the portfolio of technological abatement options and their rate of innovation, and (4) the participation of major emitters in a global agreement to control climate change (Edenhofer et al 2009).

Another important source of information in this context is the PRIMES model. Different scenarios are considered in a 2030 timeframe (see table below).The price range is between 11 and 53€/tCO2e.

Table 3 Carbon prices for 2030 in different scenarios with PRIMES

Ref	GHG35/EE®	GHG37®	GHG40®	GHG40®	GHG40/EE	GHG40/EE/RES30	GHG45/EE/RS35
35	27	35	53	40	22	11	14

Source: European Commission (2014).

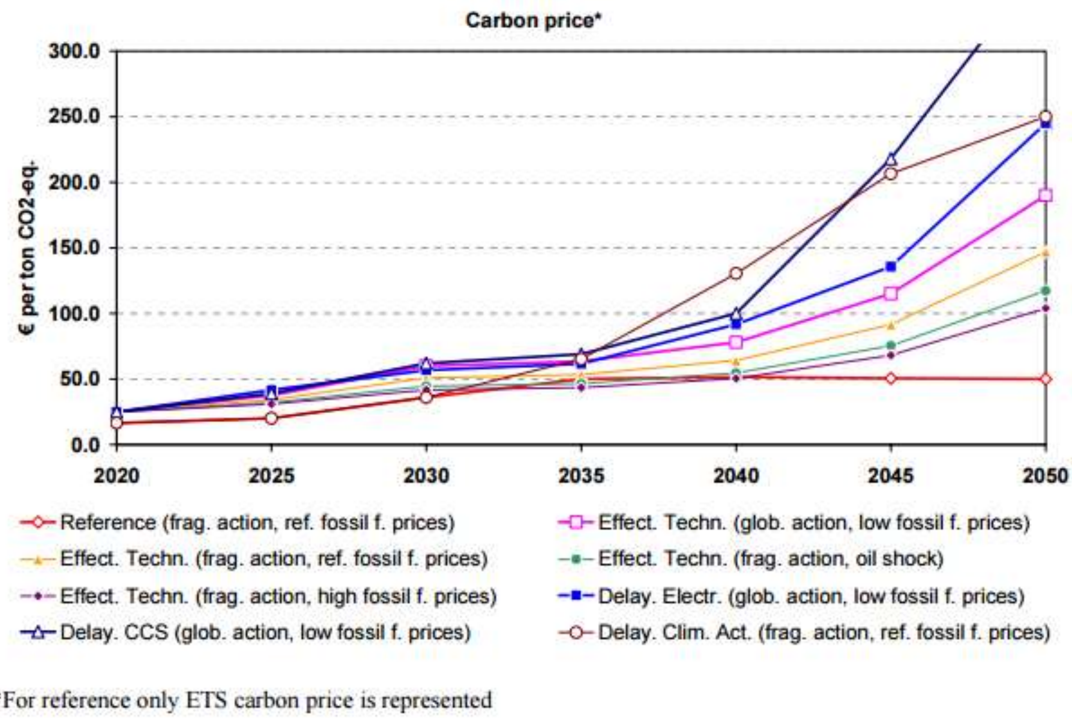
The PRIMES model has also been used for the impact assessment of the Roadmap for moving to a competitive low carbon economy in 2050 (European Commission 2011).In this document, a key policy that is assumed to be implemented is the amended EU ETS. The ETS cap declines by the adopted linear factor after 2020, resulting in a cap of nearly 70% below 2005 emission levels by 2050. ETS prices are derived endogenously on the basis of the above defined domestic emission constraint, while taking account of existing ETS flexibility, in particular with regard to banking. The following table shows the evolution of carbon prices under different scenarios until 2050.

Table 4 Evolution of carbon prices under different scenarios

Carbon price evolution*	2020	2025	2030	2035	2040	2045	2050
Reference (frag. action, ref. fossil f. prices)	16.5	20	36	50	52	51	50
Effect. Techn. (glob. action, low fossil f. prices)	25	38	60	64	78	115	190
Effect. Techn. (frag. action, ref. fossil f. prices)	25	34	51	53	64	92	147
Effect. Techn. (frag. action, oil shock)	25	32	45	47	55	75	117
Effect. Techn. (frag. action, high fossil f. prices)	25	31	42	43	50	68	104
Delay. Electr. (glob. action, low fossil f. prices)	25	42	57	62	92	136	245
Delay. CCS (glob. action, low fossil f. prices)	25	39	62	69	100	218	370
Delay. Clim. Act. (frag. action, ref. fossil f. prices)	16.5	20	36	65	131	207	250
* For reference only ETS carbon price is represented							

Source: European Commission (2011).

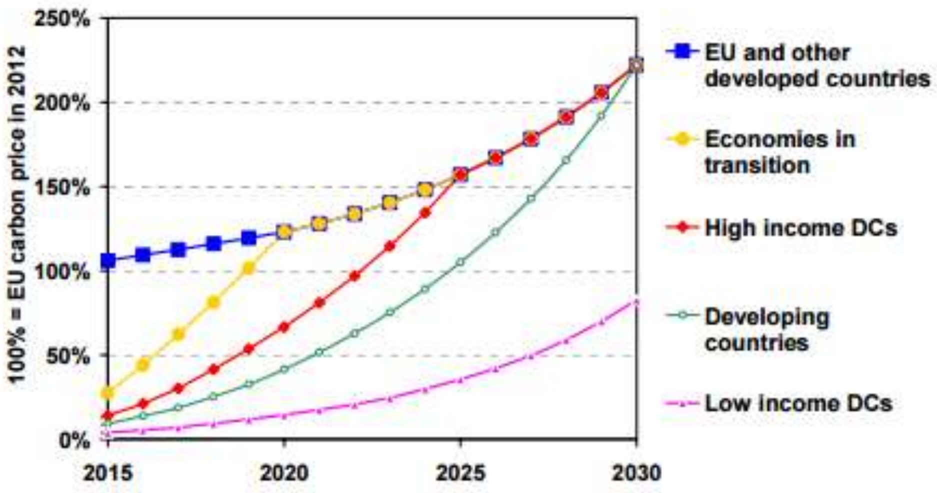
Figure 4 better illustrates the evolution of carbon prices under different scenarios.



Source: European Commission (2011).

Figure 4 **Carbon price evolution**

The POLES model developed by the JRC IPTS has been used in the impact assessment of the Roadmap for moving to a competitive low carbon economy in 2050 (European Commission 2011). It was used to estimate emissions from energy and industry on a global scale and the resulting necessary reductions in the EU. Emissions from international bunkers (international maritime and air transport)are included but not disaggregated by country or region. The global action scenario projected by POLES, is a policy case in which global emissions are reduced by around 50% with respect to 1990 levels by implementing energy efficiency policies and the introduction of a global carbon price incentive. It is assumed that there is gradual participation of the different areas in the global effort and in the international carbon market, resulting in a gradual equalisation of carbon price incentive across regions and sectors. According to this scheme, a carbon price is first established in the EU ETS sectors. In other regions the carbon price for the ETS sectors gradually catches up with the EU price. For the sectors outside the ETS, energy efficiency policies are first implemented and subsequently carbon prices are introduced. By 2030, carbon prices are equal to the ETS sectors in all countries except low income developing countries including India. By 2050, all sectors and countries globally experience the same carbon price. Although data are not provided on the level of those carbon prices, their trajectory until 2030 in relative terms is shown in figure 5.



Source: European Commission (2011).

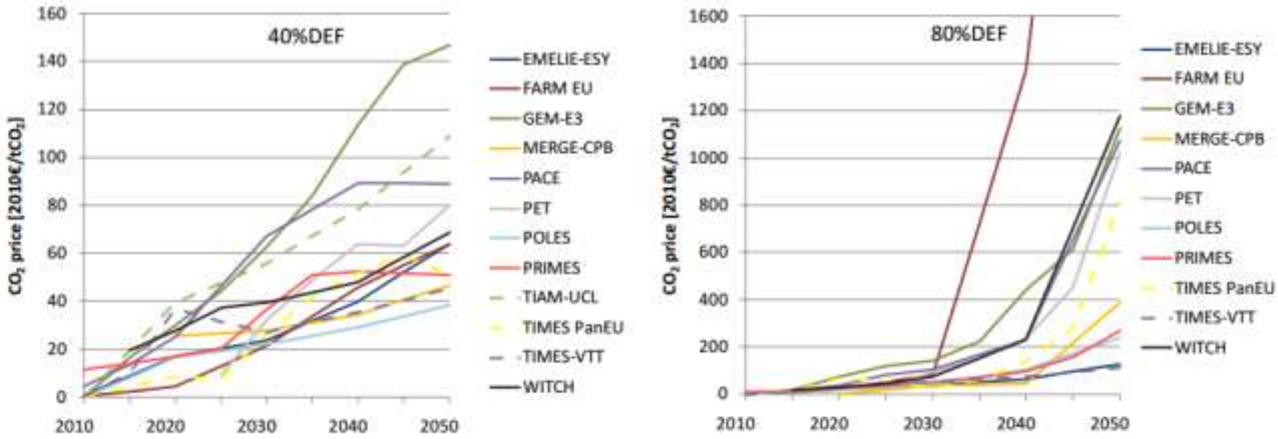
Figure 5 ETS carbon price differentials between regions over time

In the WETO-H2 study (European Commission 2006), the POLES model is used to represent the carbon constraint in a pure economic way. The carbon constraint is captured by a carbon price that includes the shadow price of the constraint and that is incorporated in the energy price to the final consumer. In this study, the carbon price in the Carbon Constraint case (CCC) reaches 100€/tCO2 in 2030 and 200€ in 2050. The monetary unit is in €2006.

Finally, the Energy Modeling Forum 28 (EMF28) study systematically explores the energy system transition required to meet the European goal of reducing greenhouse gas (GHG) emissions by 80% by 2050. The 80% scenario is compared to a reference case that aims to achieve a 40% GHG reduction target (see Knopf et al 2013 and Paltsev-Capros et al 2013). The paper investigates mitigation strategies beyond 2020 and the interplay between different decarbonization options. The models present different technology pathways for the decarbonization of Europe, but a common finding across the scenarios and models is the prominent role of energy efficiency and renewable energy sources. In particular, wind power and bioenergy increase considerably beyond current deployment levels. Up to 2030, the transformation strategies are similar across all models and for both levels of emission reduction. However, mitigation becomes more challenging after 2040. With some exceptions, our analysis agrees with the main findings of the "Energy Roadmap 2050" presented by the European Commission.

The EMF28 analysis builds upon the scenarios defined in the European Commission's Energy Roadmap. One set of scenarios considers the continuation of current policies, leading to a 40% reduction of GHG emissions by 2050 compared to 1990 (40%DEF).

For 2020, the carbon prices in the 40%DEF scenario are in the range of 5 €/tCO2 and 40 €/tCO2 and 0 and 70 €/tCO2 in the 80%DEF scenario. They are in the range of 20 and 70 for 2030 €/tCO2 and 40 and 140 €/tCO2 for 2050. The carbon prices in the 80%DEF scenario are in the range of 30 and 150 €/tCO2 for 2030 and 120 and 1200 €/tCO2 for 2050 (see figure 6).



Source: Knopf et al (2013). Note the different scales (factor of 10 between 40%DEF and 80%DEF).

Figure 6 **CO2 prices for the default reference scenario 40%DEF (left) and the default mitigation scenario 80%DEF (right)**

3.3. Carbon prices as input in energy models

Finally, another set of studies make their own assumptions on the carbon price (with more or less transparency on how these are estimated) and insert this into the models. The most important of such types of models is the World Energy Model (WEM) used in the well-known International Energy Agency World Energy Outlook.

According to the IEA (2013), the assumptions on the carbon price vary across the scenarios, reflecting the different levels of policy intervention to curb growth in CO2 emissions. It is assumed that each of the existing and planned climate policy programs continue, with the price of CO2 rising under each program over the projection period (Table 5). The price increases in the EU from an average of 10$/tonne (in year-2012 dollars) in 2012 to 20$/tonne in 2020 and 40$/tonne in 2035. But in the 450 scenario the carbon price is assumed to be as high as 125 $/tonne. Under this scenario, CO2 concentrations are limited to 450ppm (which is compatible with a 2º C increase in average world temperatures by 2100). Therefore, it represents a more stringent target than in the other scenarios.

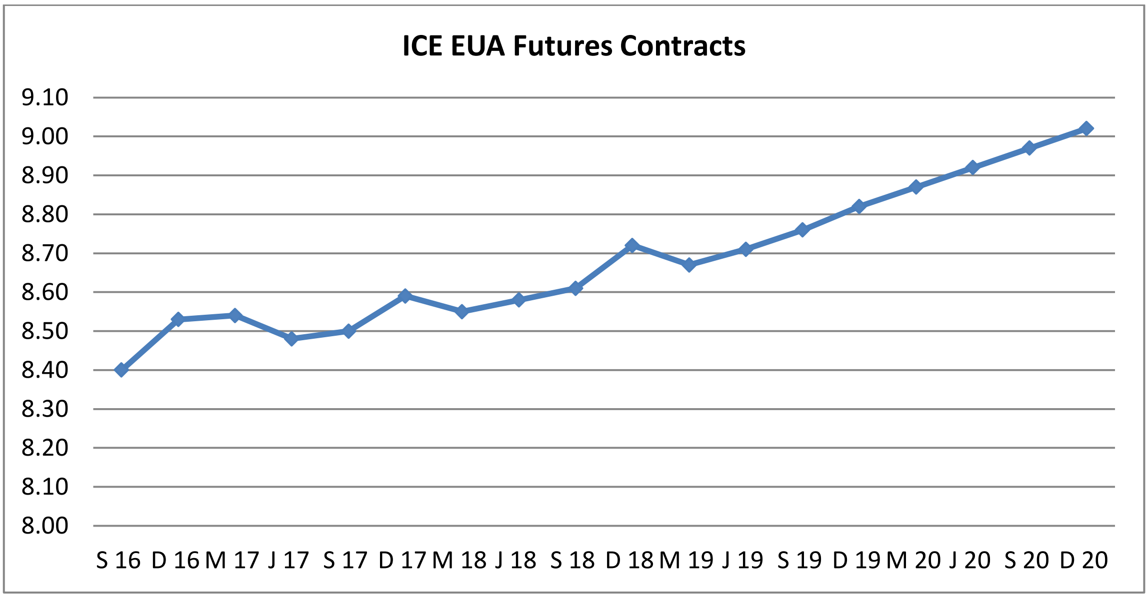
Table 5 CO2 price assumptions in the EU by scenario in the WEM (in year-2012 dollars per tonne)

	2020	2030	2035
Current Policies Scenario	15	25	30
New Policies Scenario	20	33	40
450 Scenario	35	95	125

Source: IEA (2013).

3.4. Carbon prices in forward markets

Current market information, e.g. on forward prices, provides some valuable complementary information on future carbon prices. However, while data for the next 4 years exists, the main limitation is that information on forward prices in 2030 is not available. In fact, there are not future contracts for the period beyond 2020. The following graph illustrates the carbon prices for different years. It can be observed that the prices range between 8.50 and 9 €/tCO2. Therefore, although the increase for successive years, they remain at a very low level (figure 7).



Source: Investing.com (2015). http://www.investing.com/commodities/carbon-emissions-contracts, last accessed October 22nd 2015.

Figure 7 Carbon prices in forward markets

4. Discussion

The different approaches show quite different levels of carbon prices expected in 2030 and beyond, and also different trajectories of those prices, even within a single approach (i.e., endogenous modeling). These approaches are hardly comparable, given the different data and information sources they rely on and the frequently different timeframes considered. However, plausible ranges can be inferred (Table 6). These ranges are arguably very wide. Furthermore, they refer to € for different years. Therefore, they have to be taken with caution.

Table 6 **Plausible EU ETS carbon price ranges in different timeframes and different methods (€)**

Method	Timeframe		
	2020	2030	2050
(I) Expert surveys	10.8 – 16.8	18	-
(II) Endogenous results from models.	0 - 200	11 - 250	30-1200
(III) Input in models	15 – 35	25 - 95	-
(IV) Forward markets	9	-	-

It is important to take into account that, in general, making forecasts about the carbon price in 2020 and even more in 2030 and 2050 is fraught with difficulties, since they are affected by variables whose evolution is also quite uncertain, including GDP growth levels, technology costs, fossil fuel prices and changes in the design of climate and energy policies.

In the EU ETS context, one main variable affecting the evolution of price trends in the medium term, i.e., with relevance on a 2030 perspective, is the structural reform of the EU ETS which has been the result of the concern about low carbon prices[5].

[5] For example, the analysis carried out in the Thomson Reuters report on EU energy and climate policy and, thus, carbon prices states that the single most important factor for the future carbon price is the European Commission's proposal to reform the current carbon market (Thompson Reuters 2015).

In fact, a large amount of allowances has been accumulated by firms in the EU ETS. The surplus build-up is expected to slow from 2014, but not to decline significantly during phase 3 (2013-2020) from a level of around 2 billion allowances (equivalent to a year's worth of allowances under the EU ETS cap). Commission analysis shows that even with a tightened cap in Phase IV to deliver a 40% GHG target in 2030, the surplus will reduce slowly and will remain at over 2bn allowances in 2030 (U.K. Government 2014). Several reasons are behind this oversupply, but two stand out: the economic crisis and high imports of international credits (European Commission 2015).

As a direct consequence, the lack of relative scarcity in the system has led to very low carbon prices, much lower than what would be recommendable in order to induce a sustainable energy system in the long term which allows the EU to achieve its objective of reducing greenhouse gas emissions by 80%-95% by 2050. The low carbon price results in weak investment responses to the carbon market. When businesses postpone investment in emission abatement there are increased risks of more costly, rapid investment being required later and of high carbon lock-in and stranded assets in a transition to tighter targets (U.K. Government 2014).

With inertia caused by investment cycles of often several decades duration this will render attainment of the envisaged low carbon economy by 2050 appreciably more difficult to achieve (Jansen 2014). In other words, dynamic efficiency in complying with long-term targets will be severely affected, i.e., the current market imbalance could lead to a more expensive pathway towards a low-carbon future (Gilbert et al 2014).

This concern about low prices has led to discussions on the reform of the EU ETS. As a short-term measure the sales of 900 million EUAs scheduled to be sold over 2014-2016 were postponed by the Commission until 2019-2020 as a temporary reform measure aiming to stimulate demand for allowances amid a massive surplus. This 'back-loading' of auction volumes does not reduce the overall number of allowances to be auctioned during phase 3, only the distribution of auctions over the period. The impact assessment of the European Commission shows that back-loading can rebalance supply and demand in the short term and reduce price volatility without any significant impacts on competitiveness. Back-loading was implemented through an amendment to the EU ETS Auctioning Regulation, which entered into force on 27 February 2014.

The European Commission (2012) considered 6 options in order to tackle the structural supply-demand imbalance: increasing the EU reduction target to 30% in 2020, retiring a number of allowances in phase 3, early revision of the annual linear reduction factor, extension of the scope of the EU ETS to other sectors, limit access to international credits and discretionary price management mechanisms. To these six, Jansen (2014) adds another two: shortening trading periods to some 4 or 5 years and reducing/phasing out the allocation of free allowances to energy-intensive industry. Given the political preeminence given to the Market stability reserve (MSR)(i.e., option 2) and the relevance of this option for the carbon prices in the horizon considered in this project (2030), this report has focused on this alternative, i.e., it is worth discussing the impact of the MSR and its various design alternatives on carbon prices.

The MSR is considered by the Commission as a long-term solution to the reform of the EU ETS in order to address the oversupply problem. In May 2015 it was agreed to start the MSR in 2019 rather than 2021 in the European Commission's original MSR proposal (from January 1st 2014). The legislative proposal, put forward in January 2014 at the same time as the framework for climate and energy policies up to 2030, was approved by the European Parliament on 7 July 2015 and by the Council on 6 October 2015. The Market Stability Reserve shall be established in 2018 and the placing of allowances in the reserve shall operate from 1 January 2019.

The reserve is expected to address the current surplus of allowances and improve the system's resilience to major shocks by adjusting the supply of allowances to be auctioned. It will operate entirely according to pre-defined rules which would leave no discretion to the Commission or Member States in its implementation. It will adjust the amount of permits auctioned. When the surplus exceeds a given limit, allowances will be taken off the market and put in the reserve, and returned if there's a shortage. The initial proposal by the European Commission envisaged that when the available number of allowances in the market was above an upper threshold of 833million, allowances would be removed from the market and placed in to a reserve; if the number of allowances was below a lower threshold of 400 million or if there was a strong increase in prices, then allowances would be returned from the reserve to the market.

Obviously, the main consequence of the MSR will be higher carbon prices in the 2019-2030 period. Earlier implementation of the MSR incentivises participants to undertake more abatement earlier, resulting in smoother investment over time and lower overall costs. A more equal spread of abatement effort across years reduces costs and improves cost effectiveness in achieving longer-term emissions reduction goals. Further, timely investment in abatement technologies can allow for learning effects that would help new low carbon technologies and measures become mature over time and bring down future costs of abatement (U.K. Government 2014). From 2019, carbon prices are expected to begin to diverge between the two cases and price paths (i.e. with or without the MSR), with changes in the market inventory levels falling given the start of the MSR, putting upward pressure on the EUA prices.

A few studies have simulated the impact of the MSR and its different design elements on the carbon price trajectory. The analysis of Thomson Reuters report on EU energy and climate policy (Thompson Reuters 2015) shows that the MSR will play a major role in supporting the future European carbon price. It will raise the EU carbon price to an average of €23/t in real terms between 2021 and 2030. Without it, the carbon price would average €14/t in the 2021-2030 period. The MSR will not have an impact on the 2020 timeframe, but in the 2030 horizon. Without the MSR carbon prices would be 35% lower on average during the 2021-2030 period (Ferdinand 2014). Interestingly, several scenarios with different design of the MSR are considered, and each affect the carbon price differently (change of outtake level to 20%, change of release volume to 200 million p/a, increased upper trigger limit (1000 Mt), early start date (2018), transfer of 900 million allowances to MSR, combined early start date (2018) and transfer to MSR and effect of Article 2 of MSR proposal) (Ferdinand 2014).

The UK government has also carried out analysis of the impacts of a range of MSR scenarios, which includes carbon price analysis from market analysts. In January 2015, DECC published an external research report commissioned by the Department of Energy & Climate Change and undertaken by Ecofys and London School of Economics (LSE), to assess design options for a Market Stability Reserve (U.K. Government 2014, Gilbert et al 2014). Modelling has been carried out to consider the impacts of the MSR proposed by the European Commission and an MSR that is strengthened by implementing it in 2017 and placing backloaded allowances directly into the reserve[6]. This shows that a strengthened MSR:

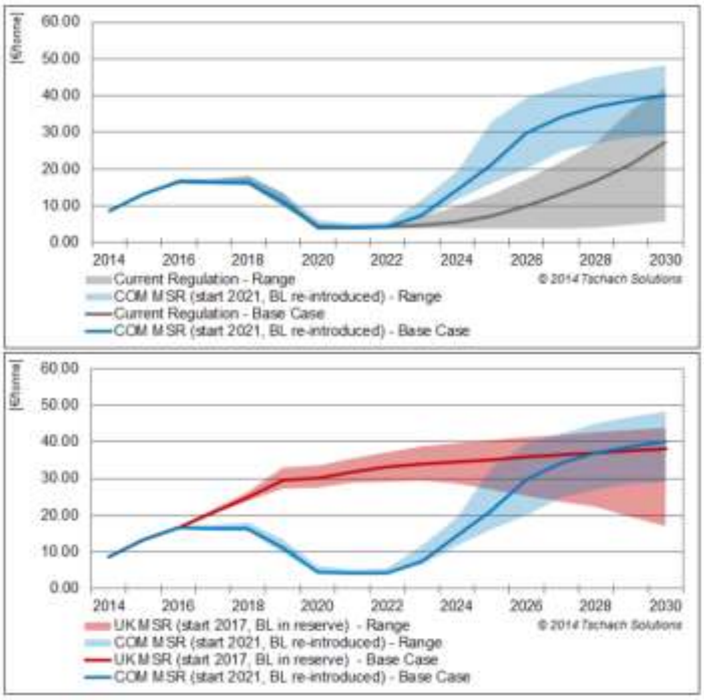
- Reduces the surplus sooner, incentivising low carbon investment sooner;
- Reduces the costs to EU ETS operators of purchasing allowances over the long term;
- Reduces uncertainty about expected future prices, and therefore de-risks low carbon investment making it more likely that such investments will be made;
- Can respond to future shocks and provide stability for the EU ETS.

Regarding the impact on carbon prices more specifically, the strengthened MSR smooths price increases over the coming decade, avoiding instability and creating a more gradual price trajectory to 2030; While prices would rise sooner under an MSR, it would not lead to increased prices overall in the medium term (2030s) compared to no MSR.

Three scenarios are considered: No MSR, the MSR in the EC proposal (EC MSR) and a strengthened MSR. The strengthened MSR differs from the EC MSR in that it starts in 2017, as opposed to 2021 under the EC MSR and that backloaded allowances are placed into the reserve in 2019 (300 million allowances) and 2020 (600 million allowances), instead of returning to the market via the smoothing mechanism as under the EC MSR.

[6] Impacts of the MSR on the volume of surplus in the market are assessed using an in-house Department of Energy and Climate Change (DECC) model based on demand for and supply of abatement. Demand and supply are estimated using Business As Usual (BAU) emissions projections and corresponding Marginal Abatement Cost Curves (MACCs) commissioned from consultants Enerdata and produced using their POLES model, a top-down global sectoral model for the world energy system5. The volume of surplus, change in auction volumes and size of the reserve are calculated under a range of scenarios and alternative MSR design options using the DECC model.

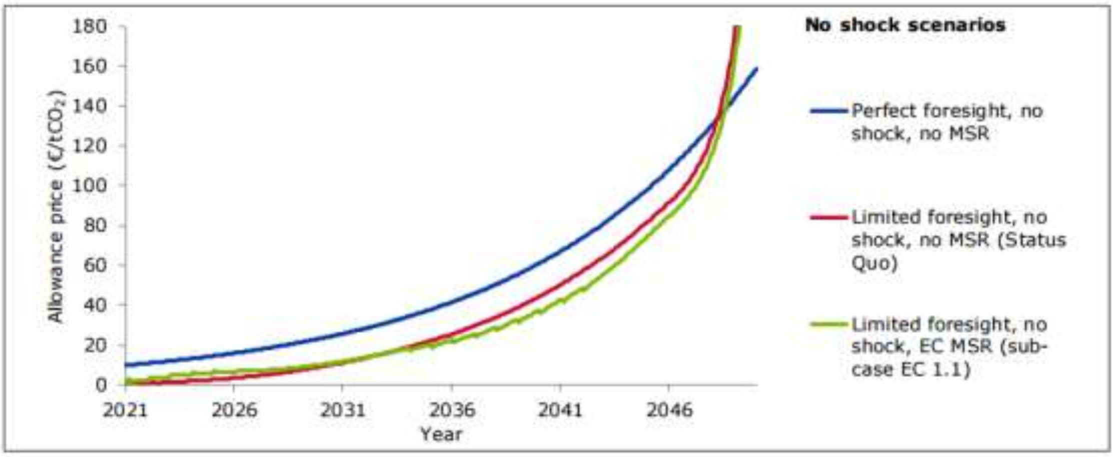
The following figure compares modeled carbon prices in the three scenarios. Ranges show projected carbon prices under different conditions of economic growth and low carbon technology deployment. It can be observed that carbon prices would be significantly higher during the whole period in the EC MSR proposal, and higher also by the end of this period (2030). Compared to the EC MSR proposal, carbon prices in the strengthened MSR would be higher during the whole period. They would diverge 2022 and then converge until 2030, when they would be at a similar level. A strengthened MSR smooths price increases over the whole period, creating a more gradual price trajectory to 2030. As a result, incentives for low carbon investment are restored sooner and are more stable. Projections of prices in 2030 under a strengthened MSR range from €40 – 70/tCO2 across a range of analysts. Modelling results often show that heading into the 2030s, price trajectories under an MSR and with no MSR begin to converge. This occurs once the MSR stops withholding allowances and the emissions constraint from the cap is restored and as such the MSR does not result in a higher carbon price overall.



Source: U.K. Government (2014)

Figure 8 **Illustrative comparisons of modelled carbon prices with no MSR, EC MSR (top) and EC MSR and strengthened MSR (bottom)**

In a separate comprehensive modelling exercise undertaken as part of the study by Gilbert et al (2014), the impacts of the MSR in nearly 30 different scenarios with varying MSR design options were assessed. This modelling undertaken also identifies a similar pattern of impacts across scenarios.8 In common with other analysts, the study found that when the MSR is introduced in 2017 rather than 2021 the surplus is reduced sooner, more abatement takes place in early years and prices increase more gradually. As shown below in Figure 9, modelled prices under the EC MSR rise sooner than with no MSR, but remain below €20/tCO2 well into the 2030s and well below the level of prices that would arise if market participants are assumed to have perfect foresight of the tightening cap and therefore undertake more abatement in early years.



Source: U.K. Government (2014).

Figure 9 **Modelled carbon prices under no MSR and EC MSR, with an assumption that market participants generally look 5 years ahead, compared to carbon prices assuming perfect foresight to 2050.**

Furthermore, the impact of the MSR on carbon prices also depends on its design elements. Some design options for a reserve in emissions trading systems can be found in literature. The main discriminator between the different designs is the type of trigger used to initiate adjustments by the MSR, including surplus, price corridor, price trend, hybrid surplus/price, changes in economic conditions, changes in production (see Gilbert et al 2014 for further details). Gilbert et al (2014) investigates the impact of several options for MSR design on the carbon prices. Their assessment focuses on only three types of MSRs: volume-based mechanism (EC proposal), price-based mechanisms, and a combination of the two dimensions (hybrid mechanisms). In addition, they consider several sub-cases according to their trigger levels (upper volume threshold, and lower volume threshold, respectively; and upper price threshold, and lower price threshold, respectively), and withholding and injection quantities (withholding quantity, and injection quantity, respectively).

Finally, Gilbert et al (2014) also show that if participants have perfect foresight of price developments and behave accordingly, the fact that some allowances are stored in the MSR will have no impact on the overall price signal as participants will anticipate the eventual return of allowances. The modelling of a range of MSRs undertaken in this study confirms that when perfect foresight is assumed, the MSR does not achieve its goals.

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