



KfW Research

# KfW/ZEW CO<sub>2</sub> Barometer 2016 – Carbon Edition

»» How the EU ETS can contribute to meeting the ambitious targets of the Paris Agreement

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# 1. Executive Summary

The objective of the KfW/ZEW CO<sub>2</sub> Barometer is to closely monitor firm behaviour in carbon markets in order to provide detailed information to policy-makers, businesses and the research community. The survey addresses a broad spectrum of topics related to company behaviour in carbon markets, such as expectations regarding carbon and commodity prices, carbon trading strategies, abatement activities and impacts of the regulatory framework on companies' competitiveness. The main findings of the KfW/ZEW CO<sub>2</sub> Barometer 2016 – Carbon Edition are:

- In 2015 the verified emissions of installations regulated by the EU ETS decreased slightly in Germany and across the EU. Relatively stable emission levels, a decrease in the use of international credits and the operationalisation of back-loading caused a slight decline in the existing oversupply on the market, which decreased from over 2 billion allowances in 2014 to 1.8 billion allowances in 2015.
- After a steady two-year positive trend, the EUA price became much more volatile from the beginning of 2016 onwards. It experienced a sharp drop of almost 50 % within six weeks and fell to a level of less than EUR 5.00 per tCO<sub>2</sub>. This was the lowest value in more than two years. After a short period of recovery to EUR 6.00, the UK referendum to leave the EU caused another price crash in June 2016, pushing the price down to EUR 4.50.
- While the Paris Agreement has the potential to be a major breakthrough in global climate negotiations, a majority of German companies participating in the EU ETS do not expect that it will be effective in reducing global emissions, not even in the long run. Similarly, they do not expect major effects on their competitiveness, employment or location of production facilities. However, many companies do expect higher carbon prices and more intense emissions trading also outside the EU.
- Many surveyed companies expect energy prices to rise until 2017. Against the backdrop of the historically low price level, 60 % of respondents expect oil prices to rise and 48 % expect electricity prices (including taxes) to increase. Gas and coal prices, in contrast, are mostly expected to remain at their current levels.
- Most of the companies (76 %) have implemented carbon abatement measures. Process optimisations and investments in energy efficiency measures have been the main activities. The EU ETS has generated only weak incentives for firms to implement carbon abatement measures. The reduction of carbon emissions has been the primary objective behind abatement activities for around 15 % of the abating respondents.
- When asked about how high the price for emission allowances has to be in order to set incentives to abate emissions, the surveyed companies stated a price of EUR 26 per tCO<sub>2</sub> as the median.
- In light of the recent negative price trend, price expectations for EUAs have been corrected downwards, but show a positive trend for the medium and long-term. On average, firms expect inflation-adjusted EUA prices to be EUR 6.71 per tCO<sub>2</sub> in December 2016 and to increase to EUR 13.03 by 2020 and EUR 24.86 by 2030. By remaining below EUR 25, however, the estimated increase in EUA prices is expected to be insufficient to generate incentives for substantial carbon abatement measures.
- Still, the EU ETS was one of the main contributors limiting CO<sub>2</sub> emissions in the regulated sectors and can therefore be seen as a key element of European climate policy. Being an important achievement of economic cooperation in the EU and beyond, the EU ETS should be maintained and further developed despite the tendency towards unilateral policies. However, the EU ETS may be further improved to ensure an efficient abatement pathway for long-term decarbonisation by providing clear guidance to regulated entities, for instance by enhancing inter-temporal price smoothing, and by improving the administrative efficiency of the system, i.e. by moving towards upstream regulation of the carbon content of fossil fuels.

The KfW/ZEW CO<sub>2</sub> Barometer is a cooperative project of the KfW Group and the Centre for European Economic Research (ZEW). It has been analysing the situation of German companies regulated under the European Union Emissions Trading Scheme (EU ETS) on an annual basis since 2009. German firms regulated under the EU ETS are invited annually to participate in the survey. This year 118 companies participated.

The KfW/ZEW CO<sub>2</sub> Barometer 2016 – Carbon Edition is structured as follows: Section 2 describes the development of CO<sub>2</sub> emissions in the EU and especially in Germany and in Section 3 a review of important recent market developments follows. Section 4 focuses on the expected impact of the Paris Agreement on regulated companies. Section 5 describes the companies'

trading behaviour in the EU ETS, their price expectations and carbon abatement measures. Section 6 delineates major strengths and weaknesses of the EU ETS and derives proposals for the further development of the trading scheme. Finally, Section 7 offers some concluding remarks.

## 2. CO<sub>2</sub> Emissions in Europe and Germany

In 2015 the EU ETS regulated the greenhouse gas (GHG) emissions of approximately 11,500 stationary installations in 31 countries (including EU28, Iceland, Norway and Liechtenstein). These installations emitted a total of approximately 1.8 billion tCO<sub>2</sub> equivalent. The proportion of freely allocated emission allowances amounted to approximately 52%. Compared with 2014, the verified emissions of stationary installations in Europe dropped slightly by 0.7% (DEHSt 2016). In addition, the EU ETS includes 1,300 entities from the aviation sector, emitting approximately 54 million tCO<sub>2</sub> equivalent (EC 2016a).

In Germany, emissions decreased slightly in 2015 from the previous year. The EU ETS regulates around 1,900 German stationary installations which emitted 455.5 million tCO<sub>2</sub> equivalent in 2015. This corresponds to a decrease in emissions by 5.7 million tCO<sub>2</sub> or 1.2% from 2014. Although the decline might seem small, it is remarkable that emissions remained at a low level after the sharp decline in 2014 (Table 1). In addition, emissions in Germany decreased at a faster rate in 2015 than EU-wide emissions (-0.7%) for the first time since the EU ETS has been in existence (DEHSt 2016).

**Table 1: Verified emissions in Germany**

	2005	2006	2007	2008	2009	2010	2011	2012	2013*	2014*	2015*
Verified emissions (tCO <sub>2</sub> in millions)	475.0	478.1	487.2	472.6	428.3	454.9	450.4	452.6	480.9	461.2	455.5
Change on previous year (in per cent)		+0.6	+1.9	-3.0	-9.4	+6.2	+1.0	+0.5	+6.3	-4.1	-1.2

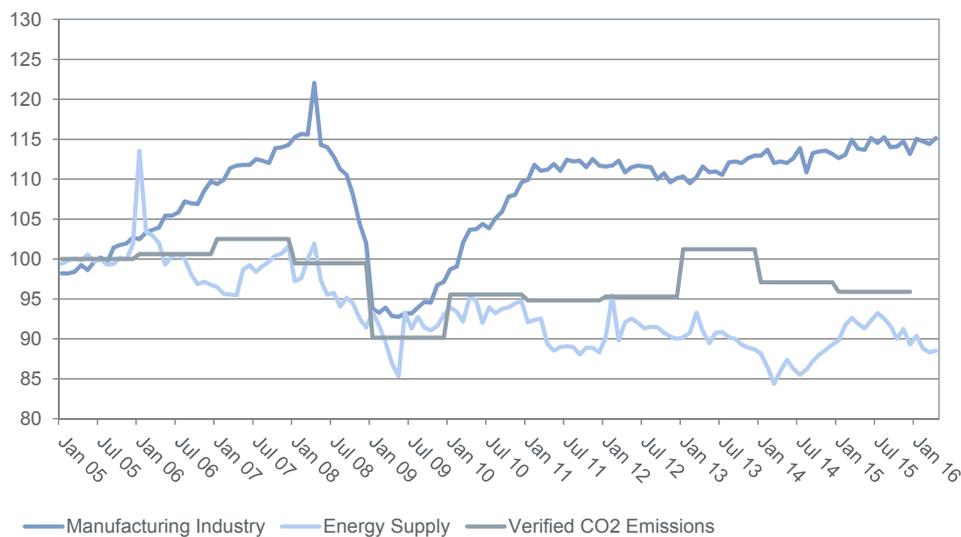
\* Includes verified emissions of newly regulated installations after scope extension in 2013.

Source: DEHSt (2016).

Emissions of CO<sub>2</sub> can partly be explained by the extent of economic activity in the energy and manufacturing industries. Figure 1 depicts monthly production indices of the manufacturing industry (without construction) and the energy sector as well as annual verified emissions. In 2015 as in 2014, the manufacturing industry contributed 27% to overall emissions in Germany, energy around 73%. The economic downturn in

2008/2009 and the corresponding drop in emissions are clearly visible. Note that the rise of emissions in 2013 was mainly driven by the scope extension of the EU ETS. In 2015 small increases in both production indices accompanied a slightly lower level of emissions (considering annual averages). This may be a first sign of effectively improved energy efficiency or abatement activities.

**Figure 1: Industrial production, production in the energy supply sector and verified emissions in Germany (2005=100)**



Energy supply covers production by installations that generate, distribute or trade electricity, gas or thermal energy. Production data are based upon the economic value of the produced units, adjusted for inflation.

Source: DEHSt (2016), Destatis (2016).

Emissions in Germany declined by 1.2 % in 2015 from the previous year. This decline almost completely took place in the energy sector (emissions decreased by 1.7 %), while emissions from the industry sectors re-

mained virtually unchanged in the same period (DEHSt 2016). Table 2 provides a more detailed overview of emission developments for various regulated industries in 2015.

**Table 2: 2015 sectoral developments of verified emissions in Germany**

	Verified emissions in ktCO <sub>2</sub>	Share of overall emissions (2015)	Change on previous year	Long- / short position** in ktCO <sub>2</sub>	Number of plants
<b>Energy sectors</b>					
Large-scale combustion installations (>50 MW FWL*)	325,558	71.47 %	-1.66 %	-302,140	448
Small-scale combustion installations (20–50 MW FWL*)	5,492	1.21 %	-2.09 %	-1,632	422
<b>Non-energy sectors</b>					
Main engines / turbines	1,300	0.29 %	2.96 %	-451	57
Combustion	2,041	0.45 %	-2.11 %	-128	74
Refineries	24,886	5.46 %	-0.39 %	-4,676	24
Iron and steel industry	37,020	8.13 %	1.98 %	12,512	126
Non-ferrous metals	2,590	0.57 %	4.39 %	-119	38
Mineral industry	34,702	7.62 %	-2.09 %	-3,245	347
Pulp / paper	5,470	1.20 %	1.15 %	1,204	152
Chemicals	16,469	3.62 %	-0.41 %	1,718	161
<b>Total</b>	<b>455,528</b>	<b>100 %</b>	<b>-1.22 %</b>	<b>-296,957</b>	<b>1,889</b>

\* Rated thermal input, \*\* incl. redistribution for byproduct gases (blast furnace gas). Negative numbers indicate “short” industries with emissions exceeding freely allocated allowances and positive numbers “long” industries (vice versa).

Source: DEHSt (2016).

Large-scale combustion installations, e.g. coal-fired power plants, are by far the most important emitters, accounting for more than 70 % of total emissions. As in the previous year, their trend of emissions is driving the overall trend in Germany. Note that emissions already declined by more than 5 % in 2014 and dropped even further in 2015. Reasons for this constantly low level of emissions, compared to the years before 2014, include the ongoing replacement of fossil with renewable energy sources and again relatively mild temperatures in the winter months. Just as the winter of 2014/2015, the period from December 2015 to February 2016 was one of the warmest winters on record since 1881 (DWD 2016). In 2014, with regard to combustion technologies, a significant decrease of 11 % and 13 % was observable for hard-coal-fired installations and gas-fired installations, respectively. In 2015, however, only hard-coal-fired large-scale installations experienced a 3.7 % emissions decline. Installations fired by the other two main combustibles, brown coal and natural gas, on the other hand, emitted around the same levels as in 2014 (DEHSt 2016).

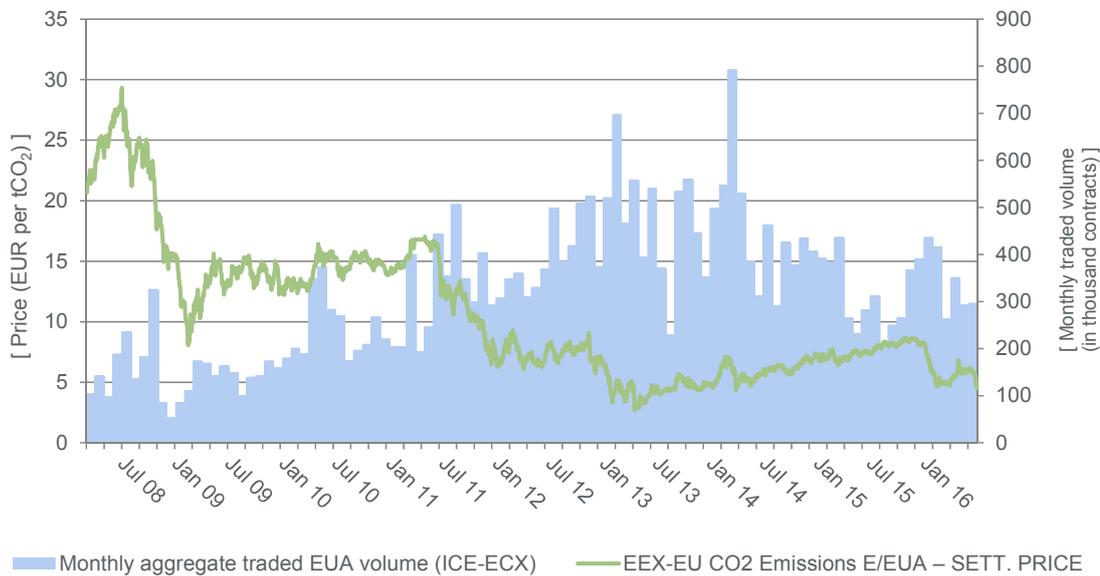
Of the 455.5 million overall tCO<sub>2</sub> emissions in Germany, 158.6 million free allowances (35 %) were issued, mainly to energy-intensive and trade-exposed indus-

tries (DEHSt 2016). The share of freely allocated emissions varies greatly between the regulated sectors, as summarised in the fifth column of Table 2, which reports the difference between free allocations and verified emissions by sector. Negative numbers correspond to a free allocation share of less than 100 % (industry is “short”), and positive numbers show an allocation of allowances in the aggregate industry that is higher than the total verified emissions (industry is “long”).<sup>1</sup> The overall difference between verified and freely allocated emissions of 2014 remained virtually unchanged in 2015, as verified emissions and freely allocated allowances decreased by almost the same amount (5.7 million tCO<sub>2</sub>). Considering only the energy sector, the short position decreased slightly to 303.7 million allowances due to lower verified emissions in 2015. The overall long position in energy-intensive industries also dropped by a small amount to 6.8 million allowances.

<sup>1</sup> Note that the data on long/short positions of the industries is based upon free allocations including the redistribution for by-product gases (e.g. blast furnace gas). In the iron and steel industry, for instance, installations exporting blast furnace gases to other installations may be supplied with free allocations for emissions which actually occur at the other installation. According to DEHSt (2016), controlling for these transfers would result in more balanced long/short positions with only the chemical industry showing a minor long position (free allocation share of 100.7 %). The energy-intensive industry in total would be short of 12.5 million allowances.

### 3. Recent Market Developments

Figure 2: EUA price and trading volumes (March 2008 to June 2016)



Source: Thomson Reuters datastream.

After a period of a relatively steady, slightly positive trend since the decision of back-loading<sup>2</sup> in spring 2014, the EUA price fell significantly in early 2016 and again in June 2016, following the UK referendum to leave the EU (Figure 2). After reaching a two-year maximum of EUR 8.67 per tCO<sub>2</sub> in late October 2015, the price stayed on a level of around EUR 8.00 until the end of the year. Then it dropped by almost 50 % within six weeks, losing the value it had gained within a year and a half. Since February 2016, the price had recovered to a level of around EUR 6.00 only to again experience a new two-year minimum of below EUR 4.50 after the Brexit vote in June 2016. With such low values, the price continues to be far too low to set significant economic incentives for ambitious abatement activities and low-carbon innovation (EC 2015, see also Section 5.3).

Regarding trading volumes, the number of traded contracts stayed on a moderate level as in the first half of 2015. On average, 14,600 contracts were traded per day in 2015 (for comparison: 21,200 in 2014). In the first six months of 2016, the trading volume stayed on a comparable level of 16,000 contracts per day.

Seemingly, after a constant increase in the first years of the EU ETS up to a maximum in 2013 and a subsequent decline, the trading activities have reached a new moderate, steady level of approximately 15,000 contracts per day.

EUA prices and trading volumes may be influenced by several developments and events in 2015 and early 2016. In the following we focus on (in chronological order) the regulatory environment (oversupply and expected revision of the EU ETS), the Paris Agreement, the price drop in early 2016, energy commodity markets, and the Brexit.

#### Oversupply of allowances and review of the EU ETS

The oversupply of emission allowances<sup>3</sup> in the market decreased slightly but remained on a relatively high level. In 2015, the surplus amounted to 1.78 billion allowances (2014: 2.07 billion allowances, EC 2016b). The operation of back-loading, a decrease in international credits and a relatively stable level of emissions are considered to be the reasons for the slight decrease in oversupply (DEHSt 2016). Still, the oversupply is far higher than the upper threshold of 833 million

<sup>2</sup> In order to limit the existing oversupply of emission allowances on the market, a number of allowances are currently held back and are not being auctioned as previously intended (back-loading). In 2015, 300 million allowances were held back to stabilise prices. After establishing the market stability reserve, these allowances will be transferred to the reserve to be auctioned when the oversupply reaches a lower threshold (see KfW/ZEW CO<sub>2</sub> Barometer 2015, Gallier et al. 2015).

<sup>3</sup> The calculated oversupply is the sum of the cumulated allowances and international credits since 2008 minus the cumulated verified emissions, retired allowances and allowances in the reserve. The rise of the cumulative oversupply in recent years has been seen as the main factor for low EUA prices and triggered the implementation of the back-loading amendment and the market stability reserve (KfW/ZEW CO<sub>2</sub> Barometer 2015, Gallier et al. 2015).

allowances which would trigger a transfer of allowances to the market stability reserve from 2019 onwards.

Regarding the review of the ETS for the fourth trading period starting in 2021, the EU has neither triggered major developments nor made any changes since 2015. It has again announced that the cap will be reduced at a faster rate (2.2% p.a. compared with 1.74% currently). The overall amount of freely allocated allowances will be kept constant but with better targeted allocation rules. The coming years will show how the regulatory framework will evolve in detail, which is particularly uncertain given that the participation of one of the largest emitters, namely the UK, is not guaranteed for the fourth trading period.

### Paris Agreement

One major event which may have affected carbon markets was the Paris Agreement on global climate action reached in December 2015 (UNFCCC 2015). The agreement is considered to be path-breaking in several dimensions. First, all parties agreed on the binding target to limit the global average temperature increase to well below 2°C above pre-industrial levels. Additionally, the parties agreed on pursuing efforts to limit the increase to 1.5°C in order to reduce the risk of dangerous climate change. Second, the agreement involves a paradigm shift as it does not differentiate between countries with and without the obligation to reduce emissions. Instead, all parties have the common responsibility to reduce emissions through national policies, notwithstanding different national capacities and circumstances. Third, by using the “intended nationally determined contributions” (NDCs) as a basis, the agreement follows a bottom-up approach instead of the top-down attempt of forcing emission targets on parties. While these achievements are recognised in the global climate arena, the Paris Agreement is only a first step. To effectively limit climate change to the target boundaries, countries have to translate their emission reduction pledges into real policies with real emission reductions, and have to make more ambitious NDCs in the future. Hence, the coming years will bring more clarity about whether the mechanism of communicated and updated NDCs will work effectively towards reaching the ambitious target the global community has agreed upon (Ekardt and Wieding 2016, Proelß 2016).

Regarding the further development of the EU ETS, it remains an open question what the Paris Agreement means for market-based instruments, such as emissions trading schemes. Importantly, the Paris Agreement does not implement any specific instrument of

emission reduction, but leaves the choice of measures to national policy-makers. However, given the ultimately voluntary character of national emission reductions, a crucial factor for the acceptance and success of national policies are the economic costs of these policies. Market-based instruments have the potential to reach specific emission targets at the lowest possible costs, and hence are a candidate for national or regional measures pursuing the intended emission targets (Schenker 2016).

In this context, the agreement sets an explicit framework for market-based mechanisms. Article 6 of the agreement presents two kinds of market-based approaches for cooperation between parties: “the use of internationally transferred mitigation outcomes” (UNFCCC 2015, paragraphs 6.2 and 6.3) and a “mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development” (paragraphs 6.4-6.7). Under the former approach, mitigation outcomes may be internationally transferred to meet the NDCs. There are no plans to create a central UNFCCC authority for monitoring this approach. International emissions trading such as the EU ETS is a possible instrument under this framework (Marcu 2016). The latter mechanism is similar to the Kyoto protocol mechanisms Clean Development Mechanism (CDM) and Joint Implementation (JI), under the authority and guidance of the UNFCCC. Countries may pursue mitigation actions in host countries to fulfil their NDCs. The main conditions include additionality of the emission reductions (a net global emission reduction) and fostering sustainable development in the host country. In contrast with the mechanisms under the Kyoto protocol, mitigation actions do not need to be on the project level, but may include large-scale sectoral policies.

Importantly, both approaches make participation completely voluntary, which some analysts consider a sign of little commitment by the UNFCCC (Ekardt and Wieding 2016). Another common feature is that the mechanisms are to be used to allow for higher ambitions in mitigation actions (paragraph 6.1). However, the success of the cooperative approaches based on the Paris Agreement finally hinges on effective national market-based instruments which allow for the integration of mitigation outcomes from abroad (Michaelowa 2016). Whether and when national regulatory frameworks that are conducive to the use of flexible mechanisms will be developed remains an open question.

### Price drop of early 2016

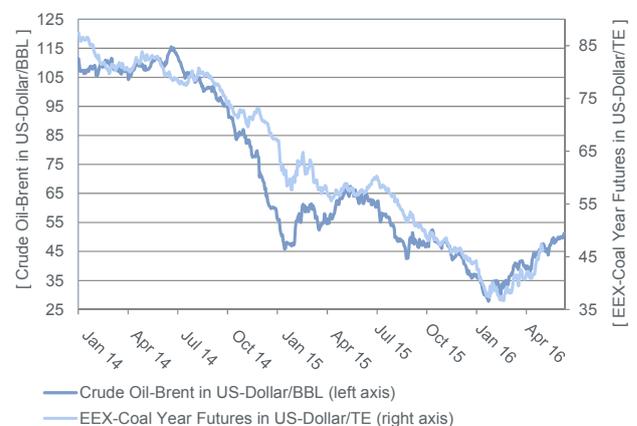
Despite its potential relevance for the long-term development of the EU ETS, the Paris Agreement had no immediately visible effect on the EUA price or trading volume in the EU ETS. However, some weeks after the agreement, the EUA price began to fall. Amounting to around EUR 8.00 at the end of 2015, it stabilised at a level of around EUR 5.00 in mid-February 2016. Commentators and analysts were surprised by this substantial price shift and named several possible reasons, none of which is unanimously considered the main explanation. Note that neither the regulatory framework, nor main economic indicators, nor commodity prices experienced any significant changes that were unique for this period. As described below, energy commodity prices did decline dramatically in the beginning of 2016, but they had already shown high volatility during 2014 and 2015 without a strong effect on EUA prices. In a survey amongst more than 300 companies and experts, Nordeng et al. (2016) found that a majority of respondents name a new reading of fundamentals (i.e. the awareness that the oversupply will be sustainable) and a delayed response to downward trends in other energy markets as the main reasons. Again, the question as to why these adjustments only happened in early 2016 – and not earlier – remains open. Consequently, several developments have been proposed to explain the price drop of early 2016: On the sellers' side, some analysts<sup>4</sup> state that a small number of large industrials sold large amounts of their EUA reserves in response to acute financial stress, making cash while paying little attention to prices. Other observers find that large buyers (utilities) were relatively inactive on the market in the respective weeks, possibly due to sufficient reserves for the current compliance period. Another suggested reason for a comparably low demand in winter 2015/2016 was the mild weather in Germany. Regarding the regulatory framework, there was little activity that may have triggered the price crash. If at all, the announcement of Poland's government to question the market stability reserve in court in early January 2016 may have had an impact. Finally, most analysts agree on their statement that the price crash was at least exacerbated if not triggered by speculators betting on falling prices.

### Energy commodity prices

We have already mentioned falling energy commodity prices. Figure 3 depicts the development of crude oil

and coal prices from January 2014 to June 2016. After the sharp drop in 2014 and 2015, prices fell again in early 2016. However, most analysts do not explain the EUA price drop with falling energy commodity prices, as intuition suggests a negative instead a positive correlation. Falling energy commodity prices may positively affect energy production, hence emissions, and finally carbon prices. A common trend in energy commodity prices and carbon prices may better be interpreted as a result of a third factor which may potentially drive both. The overall global economic performance could be a candidate for such a driving force. In fact, early 2016 saw a downturn in most financial markets in the world.

**Figure 3: EEX Coal future price and crude oil (Brent) price (January 2015 to June 2016)**



Source: Thomson Reuters datastream

### After the Brexit

Finally, carbon markets were significantly affected by the surprising result of the UK referendum to leave the EU in late June 2016. Prior to the referendum the EUA price moved within a bandwidth between EUR 5.50 and 6.00. On 24 June, when the leave vote of the UK referendum became apparent, the price plummeted by 12% and continued to fall to a level of EUR 4.50, bouncing back to the level which formed the base of the price drop of early 2016.

There are two broad reasons for this drastic downturn – demand and supply effects. Regarding the demand effects, the worries of a general economic downturn following the UK's vote to leave the EU may have affected carbon markets via a decreasing demand for emission allowances, as observed during the recession of 2008/2009.

<sup>4</sup> We reviewed carbon price analyses of the following market observers: Advantag AG (<http://www.advantag.de/news/emissionshandel-co2-marktbericht-vom-11-07-2016-p2537>), Carbon Pulse (<http://carbon-pulse.com/category/eu-ets/>), Redshaw Advisors Ltd. (<http://www.redshawadvisors.com/category/weekly-carbon-update/>).

More importantly, supply effects have occurred. These, however, hinge on the further development of the general EU-UK relationship and specifically whether and in what way the UK will remain part of the EU ETS. There are good reasons to expect that the UK will stay within the EU ETS in some way: In the past, the UK was one of the leading actors in developing and strengthening the EU ETS. The country has set ambitious national mitigation targets which may be reached more easily under the existing EU ETS, instead of developing new national mechanisms. Finally, a trade agreement which is generally desired by both the UK and the rest of the EU will be more easily reached under a common climate policy regime such as the EU ETS. Note that the UK would not be the first non-EU member in the EU ETS. The non-EU members Iceland, Norway and Liechtenstein are currently participating in the EU ETS.

However, even if the UK remains in the EU ETS, its political influence on setting the regulatory framework, reviewing and further developing the scheme will most probably diminish. This is important given that it has played a relevant and constructive role in building up the system, developing and implementing policies which strengthened the systems and supported EUA prices in the past. Hence, the expectation of losing an influential advocate for a strict and effective ETS, including a more stringent cap, may be one important reason for the observed decline in EUA prices following the referendum. Moreover, some analysts state that the prospects of the UK eventually leaving the EU ETS has triggered major selling activities among UK-based emitters which have accumulated substantial reserves for the upcoming years.

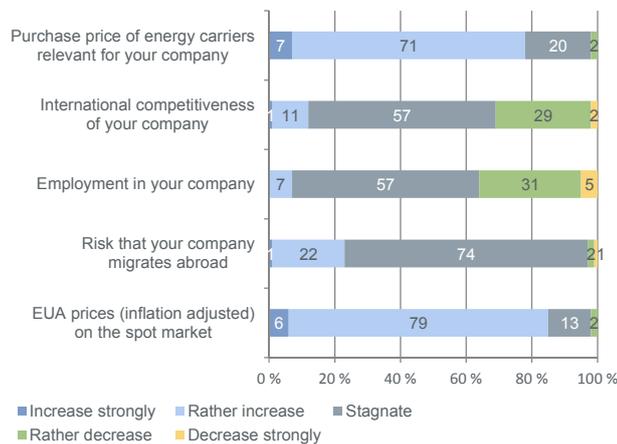
## 4. Paris 2015: How Regulated Companies Perceive the Agreement

The Paris Agreement is considered an important step towards effective international cooperation to fight climate change. However, uncertainties remain concerning implementation at national level. It is not clear if the Paris Agreement will affect German climate policy at all. Therefore, firms regulated under the EU ETS and surveyed in the KfW/ZEW CO<sub>2</sub> Barometer 2016 were asked to evaluate the expected impacts of the Paris Agreement.

Surprisingly, the majority of respondents expect that the agreement will not cause a long-term reduction of worldwide GHG emissions (60%). Only 25% expect long-term reductions of worldwide GHG emissions to be facilitated by the agreement. The remaining 15% are unsure about the effects. Thus, the prevailing expectation of the respondents is that the agreement will fail to contribute to a reduction of global GHG emissions.

However, a majority of regulated companies expect moderately increased prices for energy commodities by 2020 (78% expect price increases, the majority of which expect only moderate price increases, Figure 4).

**Figure 4: What impact do you expect the Paris Agreement to have on your company until 2020?**



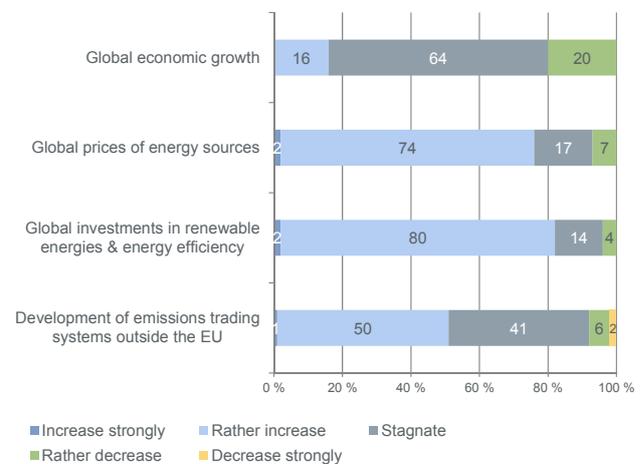
Source: Own survey.

Despite this expectation, a majority of companies do not expect changes with respect to their own competitiveness (56%). Still, almost one-third of companies (31%) expect a decrease in competitiveness. The same picture evolves for firms' expectations about the development of their employment: most firms expect no

change at all (57%), some a slight decrease (35%). Similarly, the risk of carbon leakage (e.g. shifting production abroad) is considered very low, as three-quarters of respondents state that the likelihood of moving production abroad by 2020 is unaffected by the agreement (74%).

The responses remain very consistent when asked about global instead of company-specific consequences of the Paris Agreement (see Figure 5). A majority of respondents expect no change in the world economy (64%) by 2020, while 20% expect a slight decline in growth. Again, this holds despite the expectation of rising energy prices (74%). Interestingly, 80% of the responding firms expect investments in renewable energy and in energy efficiency to grow. Half of respondents (51%) further expect that the Paris Agreement will create momentum for the implementation of new emissions trading schemes abroad.

**Figure 5: What impact do you expect the Paris Agreement to have by 2020 in general?**



Source: Own survey.

The Paris Agreement is expected to have a bearing on EU carbon prices as well: In the long run until 2020, firms expect EUA prices to increase (84%, of which a large majority expect only weak price increases; see Figure 4). This is in contrast to the expectations mentioned above, namely that the agreement will not be effective in reducing global emissions. Potentially, statements regarding price developments may be influenced by the surprisingly low price levels at the time of the survey.

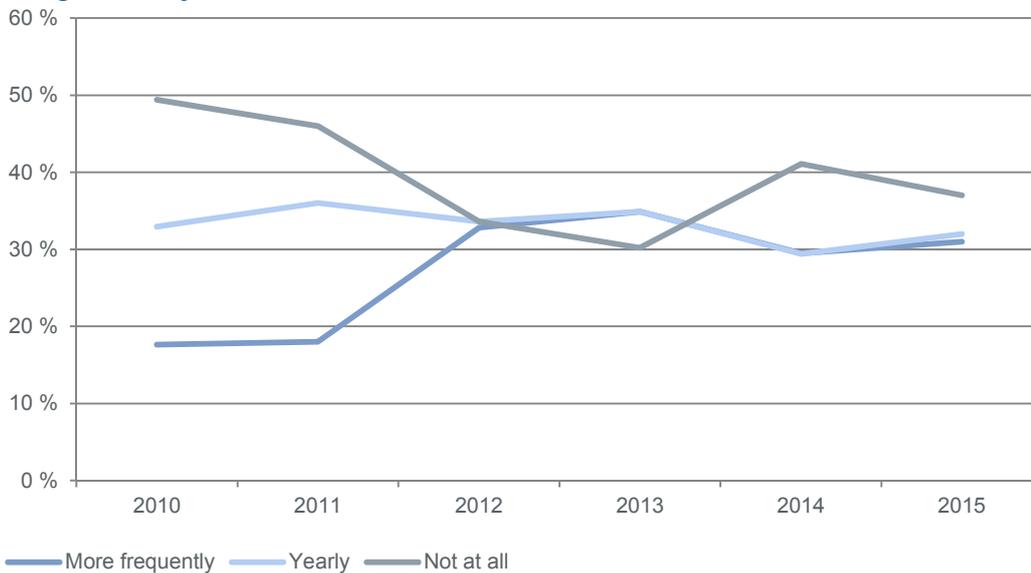
In the short run, firms see no effect of the Paris Agreement on EUA prices. This is supported by the fact that only 2 % of firms in the survey consider the Paris Agreement as the main driver for the EUA price drop observed in late 2015 and early 2016 (see Figure 11 in the following chapter).

Our results are well in line with another survey on carbon market expectations globally conducted by Thomson Reuters in February and March 2016 (Nordeng et al., 2016). Although the survey respondents claim to be satisfied overall with the Paris Agreement, most find it unlikely that it will set the world on course to reach the

2-degree target (ibid, p. 9). International carbon markets might expand or build links until 2030 as a consequence of the agreement, as expected by about 40 % of compliance companies. Overall, the vast majority of regulated companies expect the Paris Agreement to have no sustained effect on global emission reduction. Hence, the companies are rather pessimistic regarding national implementation of internationally agreed mitigation targets outside the EU. This is consistent with the view that ratification and implementation of substantial climate policies will take time. Consequently, only a minority of respondents currently expect effects on competitiveness, employment, or carbon leakage.

## 5. Trading, price expectations, and carbon abatement

**Figure 6: How often has your company traded emission allowances (EUAs, CERs or ERUs) during the last year?**



Source: Own survey.

### Trading of emission allowances

One important indicator for companies' involvement in the EU ETS is their trading participation. Up to the year 2013 the share of surveyed firms reporting that they were actively participating in the European carbon market increased steadily to 70% (the share of firms who have not traded at all decreased to 30% in 2013, see Figure 6). Since then, the share of companies stating that they engaged in trading decreased to 59% in 2014 and yet increased slightly by 4 percentage points in 2015. Still, previous levels of trading volumes have not been reached again. One likely reason for this development is the prevalence of excess allocation from past years in the EU ETS.

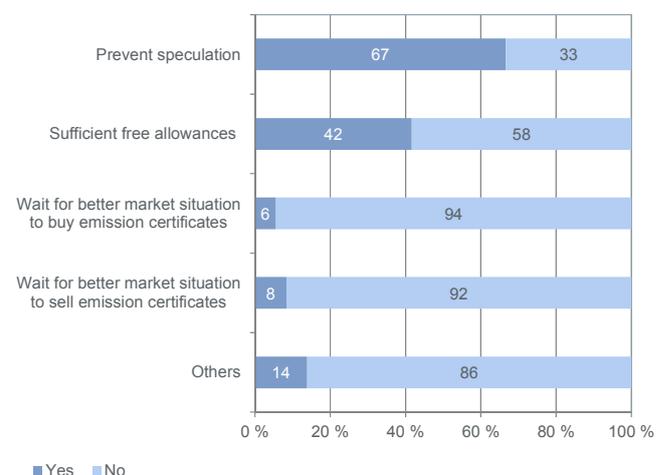
This development mirrors the overall trading levels (see chapter 2) which appear to be stagnating at the medium level.

About half of the surveyed companies that were trading emission certificates in 2015 do so only once a year (32 percentage points out of 63 percentage points). Companies that trade more frequently than yearly, usually trade on a quarterly basis.

Furthermore, the survey results show that two primary factors kept firms from trading emission allowances: prevention of speculation (67%) and possession of a sufficient number of freely allocated emission allowances (42%; see Figure 7). Only a very small fraction

of the surveyed companies reported that they were waiting for better market conditions to either buy or sell emission allowances. Compared with last year's survey, there has been a striking increase of companies reporting that their reason for not trading emission allowances was to prevent speculation (67% in 2016, up from 36% in 2015).

**Figure 7: Reasons why companies did not trade emission allowances in 2015**



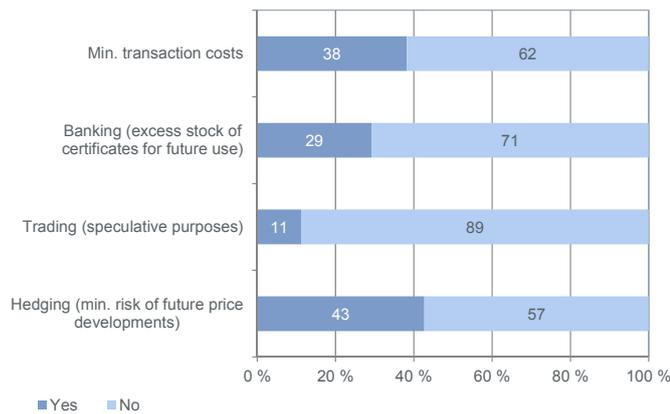
Source: Own survey.

Regarding the self-reported situation of companies in the EU ETS, the 2016 survey reveals that one-third of the companies need to purchase major additional amounts of emission allowances in order to be compli-

ant. Another one third of respondents reported minor extra purchases. The remaining companies reported no need for purchasing emission allowances at all. More precisely, 20 % reported a balanced account and 16 % reported a surplus of emission allowances. Compared with the previous year, there has been a shift of about 10 percentage points moving from minor to major purchases.

Looking at the reasons for trading emission certificates, we observe a trend towards a more cautious behaviour in the surveyed companies compared with last year's survey. More precisely, hedging in order to minimise the risk of future price developments (43 %, see Figure 8) is now the number one motive for trading, followed by the minimisation of transaction costs (38 %)

**Figure 8: What strategy has your company pursued regarding trading of emission allowances since the end of February 2015?**



Source: Own survey.

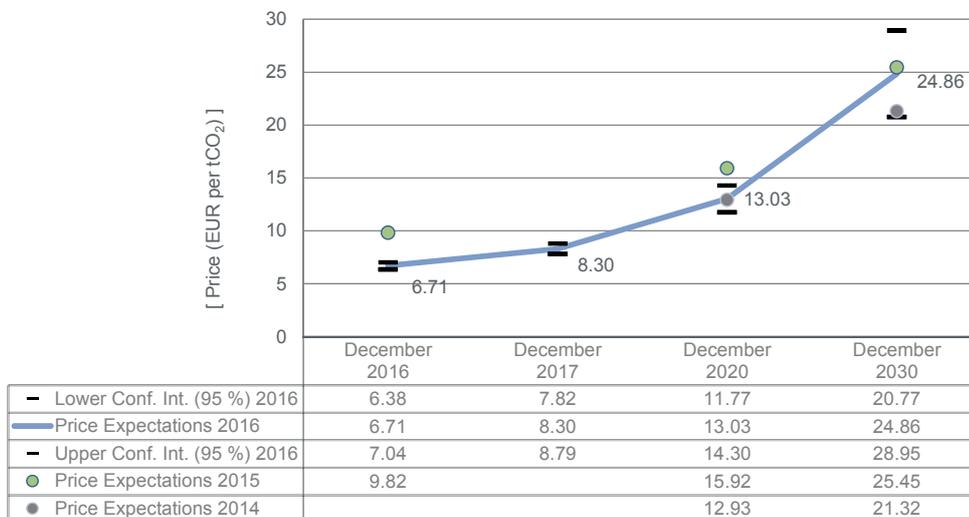
and banking (29 %). In 2015, both the minimisation of transaction costs and banking were seen as more relevant than hedging. The increased importance of hedging mirrors a changed trading behaviour in a market that has been much more volatile than at the time of last year's survey (see section 3).

**Price expectations**

Regulated companies were asked about their short, medium and long-term expectations of EUA prices. Figure 9 depicts the corresponding results.

Against the background of a EUA price drop in early 2016 (see section 3), firms have adjusted their price expectations downwards. Hence, at the time of the survey (spring 2016), the companies expected EUA prices to be at EUR 6.71 per tCO<sub>2</sub> on average in December 2016 and to increase up to EUR 8.30 by December 2017. Remarkably, these expectations are much lower than those reported in the previous year,<sup>5</sup> which reflects the sharp and unexpected price drop for emission certificates observed in early 2016. It is worth noting that the recent referendum in the United Kingdom to leave the EU contributed to a further decline in EUA prices, but this development is not reflected in the price expectations as shown in Figure 9. Interestingly, in the medium and long term, however, the surveyed companies continue to expect a strong price increase. Thus, the expected certificate prices for 2030 have hardly changed from last year's survey and continue to remain at a level of about EUR 25. However, the variance of price expectations has increased, implying larger uncertainty about future prices compared with last year's expectations. In order to evaluate the driving forces of

**Figure 9: Price expectations for EUAs (inflation-adjusted)**

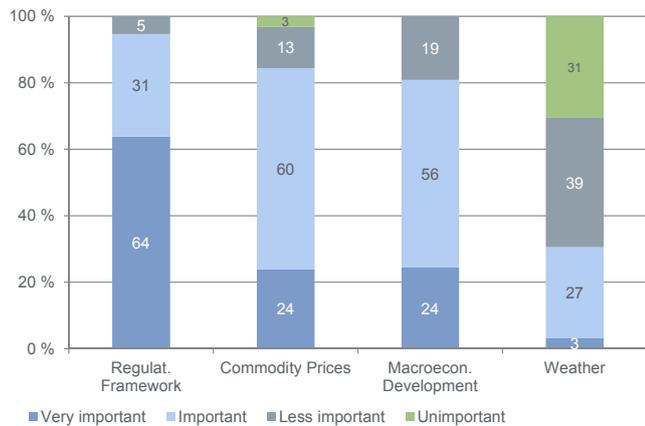


Source: Own survey.

<sup>5</sup> Only the expectations for December 2016 are directly comparable, as depicted in Figure 9.

EUA price expectations, we asked the surveyed companies to evaluate the importance of different factors which potentially influence EUA prices. The regulatory framework is seen as the single most important factor in this regard, as 95 % of the surveyed firms consider it to be important or very important (see Figure 10). The European Commission pursues two strategies to reduce the oversupply of emission allowances (see also Chapter 3), back-loading and the market stability reserve to recalibrate the regulatory framework. In addition to the regulatory framework, commodity prices and the macroeconomic development are considered about equally important as drivers of EUA prices, as 84 and 80 % of firms, respectively, regard them as important or very important. These results have to be regarded in light of price drops for energy commodities which occurred in late 2014 as well as in 2015. Weather conditions, by contrast, do not seem to be a relevant driver of EUA prices, as only 30 % of the participating firms stated that this factor was important or very important to them.

**Figure 10: What are the most important factors that influence the EUA price?**

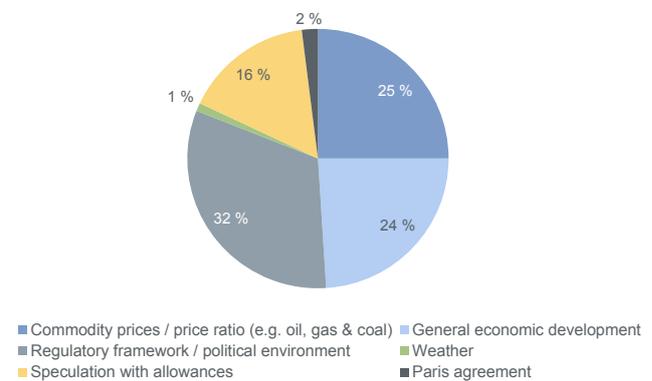


Source: Own survey.

The sharp drop in EUA prices from about EUR 8.60 in December 2015 to about EUR 4.90 in March 2016 is still not well understood. Therefore, regulated firms were asked to name the most important reason responsible for the EUA price drop. The price drop is ascribed primarily to regulatory changes together with the political framework of the EU ETS (32%), as shown in Figure 11. One quarter of respondents expressed the view that the EUA price drop was attributable to the development of commodity prices. The decline in the

EUA price occurred simultaneously with a decline in energy prices (see Chapter 3). Another one fourth of respondents see the EUA price drop in relation to the general economic development. This view fits the recent trend of increased economic uncertainty reflected by falling stock prices. Speculation with EUA certificates, which could lead to higher price volatility, is considered the main driver of the price drop by 16 % of respondents. By contrast, weather conditions (1 %) and the Paris Agreement (2 %) are not considered to be of any importance for the price decline.

**Figure 11: Main reason for EUA price drop in early 2015**

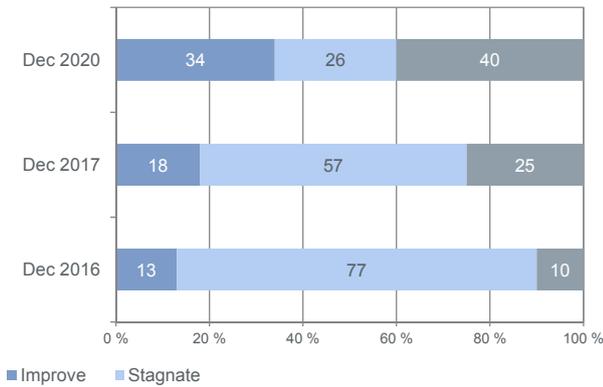


Source: Own survey.

The economic outlook and energy commodity prices are important drivers of EUA prices. Therefore, we asked the respondents about their expectations regarding energy prices and the future economic development.

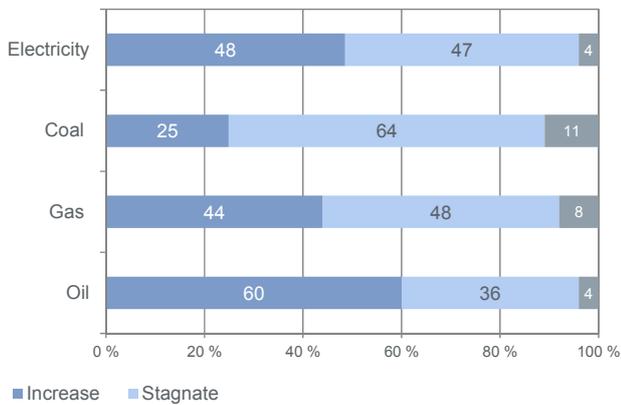
The year 2015 saw historically low price levels for energy commodities, particularly for oil. Moreover, electricity prices for the German industry (net of taxes and royalties) in 2015 were at the lowest level since 2005. In light of low energy commodity prices and in expectation of possible further increases in taxes and royalties caused by national policies (e.g., the *Energiewende*), it is no surprise that the surveyed firms expect rising prices for electricity and for other energy commodities (see Figure 12). For example, the increasing price expectations for oil (60 % of firms expect oil prices to rise until March 2017) may reflect the fact that the oil price passed a period of recovery during the survey period, albeit on a historically low level.

**Figure 12: How would you assess the development of the macroeconomic situation until March 2017?**



Source: Own survey.

**Figure 13: How would you assess the development of energy prices until March 2017?**



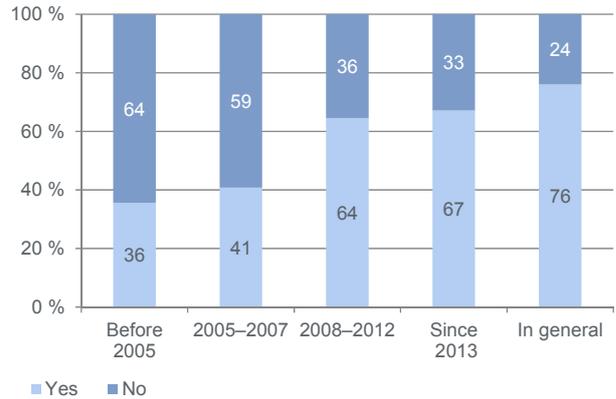
Source: Own survey.

Moreover, expectations about rising energy prices are closely tied to expectations about the macroeconomic development (Figure 13). While for 2016 and 2017 the majority of respondents expect a stagnating macroeconomic situation, expectations for 2020 are more polarised with a slightly pessimistic tendency (40 % of firms expect a downturn vs. 34 % an improvement). Compared with last year’s results, the current macroeconomic outlook is a little more pessimistic. This holds for both the short- and long-term perspective.

**Carbon abatement**

The aim of the EU emissions trading scheme is to set incentives for carbon emission reductions at the firm level. Therefore, the regulated companies were asked about their abatement activities. Three-quarters of respondents (76 %) reported having reduced CO<sub>2</sub> emissions at least once (Figure 14). The share of firms reporting abatement activities has increased with each phase of the EU ETS.

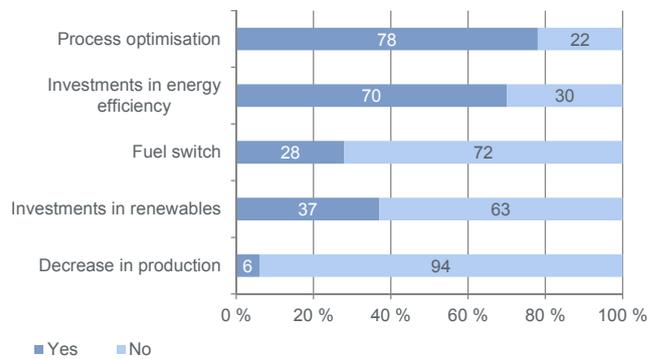
**Figure 14: Did you conduct CO<sub>2</sub> abatement activities on one or more installations? If yes, when?**



Source: Own survey.

As in previous years, process optimisation (78 %) and investment in energy efficiency (70 %) are the most frequent approaches to GHG mitigation (Figure 15). In addition, investment in renewables slightly increased on the previous year (37 % in 2016, 33 % in 2015). Fuel-switching was reported as an abatement activity by 28 % of companies (up from 20 % in 2015).

**Figure 15: What kind of abatement strategy was conducted?**



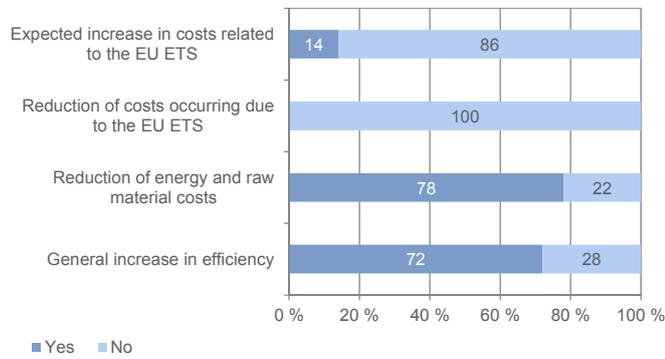
Source: Own survey

The reduction of carbon emissions is usually merely a side effect of process optimisation or investment. Only 15 % of the respondents which reported abatement activities also stated that the reduction of carbon emissions was the primary objective of the undertaken measures.

In most cases, mitigation of GHG emissions occurs as a side effect: The reduction of energy and raw material costs (78 %) is one of the main causes for implementing abatement activities, just like a general increase in efficiency (72 %; Figure 16). The costs incurred due to the EU ETS today or likely in the future do not play a major role as drivers for abatement activities. This is

another indication that the costs associated with the EU ETS are currently moderate and that other types of cost are of greater importance.

**Figure 16: If your company conducted activities contributing to carbon abatement, please name the main reasons for their implementation.**



Source: Own survey

Significant incentives for increased abatement efforts would occur at a price level of about EUR 25, according to the survey results.<sup>6</sup> About 50 % of respondents reported a threshold price associated with increased abatement incentives of about EUR 20 to 35. These values have been constant over the past three survey years and appear to be robust over time.

<sup>6</sup> After removing the top and bottom 1 % of outliers, the mean value is at about EUR 26.



## 6. Emissions trading in Europe – a retrospective and the way forward

The KfW/ZEW CO<sub>2</sub> Barometer has observed the European carbon markets with a focus on the perspective of regulated German companies for more than seven years now. In the following section, we draw upon this expertise and delineate the main strengths and weaknesses of the EU ETS in its current format. We also provide an outlook on possible improvements of the scheme.

By implementing the ETS, the EU has provided a sound policy framework for EU-wide climate protection. First labelled as ‘a grand policy experiment’, the EU ETS is now a mature market. Even with emissions trading schemes on the horizon in China, the EU ETS is still the largest piece of climate policy in effect.

However, there are a number of issues that need to be addressed. One of the most important aspects in this respect is uncertainty. Many investments in mitigation are irreversible and have a long durability. Hence, excessive uncertainty may impede or delay investments although they may be profitable and benefit the climate in the long run (Buchholz and Heindl, 2015).

Two types of uncertainty can be distinguished: Uncertainty related to general market conditions and uncertainty regarding the climate policy framework (regulatory uncertainty). The former type of uncertainty usually is what ‘moves markets’. In essence, markets exist to allocate resources under changing conditions and the EU ETS – as a mature market – is well able to cope with this type of uncertainty. Regulatory uncertainty on the other hand can be avoided by providing a transparent and reliable climate policy framework. This would help companies to make the right decisions at the right time. In fact, regulatory uncertainty has had a major impact on the European carbon market in recent years. In order to provide more stability and guidance, more must be done to provide a reliable policy framework. To name a current example: It is crucial that uncertainties about the future participation of the UK in the EU ETS are removed as soon as possible.

Volatile EUA prices are closely related to regulatory uncertainty. The decline in industrial output in some EU member states in recent years had its bearing on the demand for emission allowances and caused the accumulation of excess volumes of EUAs associated with a decline in EUA prices. While the EU ETS continues to ensure that the overall quantity target for GHG emis-

sions in the EU will not be exceeded, the current weak price signals may lead to misguided, carbon-intensive investments and therefore deviate from the efficient abatement pathway for the long-term decarbonisation of the European economy (Neuhoff et al, 2015). This argument is sound as there is evidence that increased abatement efforts in the industry would require EUA prices of at least EUR 25.

As a reaction to low carbon prices, the EU Commission implemented the ‘market stability reserve’. Under this regime, emission allowances will be temporarily removed from the market in order to provide support for EUA prices. This strategy, however, appears to be insufficient to remove fundamental uncertainty. As an alternative, a mixed strategy of price and quantity regulation could be implemented. Under such a regime the regular issuance of new allowances would come to a halt if a certain lower price threshold, a price floor, was reached (Goulder and Parry, 2008). Guaranteeing a minimum price trajectory in the EU ETS over time could effectively reduce uncertainty – and consequently risks – in the EU ETS. It could provide stable incentives for decarbonisation while simultaneously ensuring that the overall quantity restriction for EU-wide GHG emissions is not exceeded. Therefore, moving towards a mixed regime of price and quantity regulation is a possible avenue for the future development of the EU ETS.

Another important problem is related to ‘overlapping regulation.’ This problem occurs if the design of national measures fails to consider their impact on the EU ETS and visa versa. One example is the promotion of renewable energy production at the national level (Heindl et al., 2015). Since a large share of emissions covered by the EU ETS is caused by utility companies, increased deployment of renewable energy carriers will tend to decrease emissions from coal- or gas-fired power plants. If the reduced emissions, caused by enhanced renewable generation, are not already considered in the cap of the EU ETS<sup>7</sup>, the unused emission allowances will be purchased by other emitters; hence there will be no emission mitigation effect on the European level. Moreover, the decline in demand will tend to decrease the EUA price. In this case, policy-makers face a dilemma, since the positive ecologic effects of increased deployment of renewables in energy production is offset by the EU ETS. This problem is relevant in

<sup>7</sup> The 2008 renewable targets have been included in the TIMES Scenario, which was the basis for the cap of the current trading period.

practice, for instance, with respect to the German *Energiewende* policy. While the promotion of 'green technologies' is useful (Acemoglu et al., 2012), any national policy must be balanced with existing EU climate policy in order to be effective. This urges us to look for a closer harmonisation of EU climate policy and national climate policies. For example, as most of the member states have clearly defined targets and an indicative trajectory for the share of renewable energies, the resulting emission effects should be included in the cap reduction rate of the ETS for the fourth trading period. Any positive deviation from the renewables trajectory could be accompanied by a retirement of a respective number of emission certificates in order to avoid the mentioned detrimental effects. Recently, the Swedish government has announced a policy heading in this direction. The government plans to purchase and retire emissions worth EUR 32 million annually from 2018 to 2040 (Government Offices of Sweden 2016). Moreover, individuals and businesses are invited and encouraged to purchase and cancel allowances, e.g. by tax deductions. This example, although small in quantitative terms, shows that national climate policies that strengthen the EU ETS and reduce emissions effectively and at low cost can be designed.

Efficiency and effectiveness also require that regulation be well organised. There is room for improvement in the EU ETS, e.g. with respect to decreasing administrative costs incurred due to compliance obligations of regulated companies.<sup>8</sup> The EU ETS covers a large number of rather small installations. These installations emit only small amounts of GHG each year, but face compliance obligations similar to larger emitters of GHG. This results in rather unequally distributed transaction costs, which are particularly high for small emit-

ters (Heindl, forthcoming). This problem can be mitigated by the 'Australian model' (Jotzo, 2012). Under such a regime, strict upstream regulation would be applied, which means that the carbon content of fossil fuels (oil, gas, coal) is regulated by the ETS once these fuels are imported or brought on the market. In this case, many companies which purchase fuel inside the EU could be released from compliance obligations in the EU ETS, since the carbon content of fuel is already regulated. This model has the potential to increase the efficiency of the EU ETS but it would require stronger harmonisation of European energy markets and also of energy taxation.

Overall, the EU ETS may be further improved by providing clear guidance to regulated entities, for instance, by imposing a carbon price floor, and by improving the administrative efficiency of the system, i.e. by moving towards upstream regulation of the carbon content of fossil fuels. Stronger collaboration of EU member states and harmonisation of climate and energy policies would be required in order to improve the EU ETS. Unilateral climate protection efforts need to be scrutinised as to whether and how they interfere with EU climate policy in order to ensure the effectiveness of both European and national policies.

In retrospect, the EU ETS has contributed to limiting emissions in the regulated sectors effectively for more than ten years. The EU ETS, therefore, remains the backbone of EU climate policy and is an important part of the common market. As a valuable achievement of economic cooperation in the EU and beyond, the EU ETS should be maintained and further developed despite the tendency towards unilateral policies.

<sup>8</sup> The topic of administrative costs was analysed in more depth in previous issues of the KfW/ZEW CO<sub>2</sub> Barometer, e.g. in 2010 and in 2011 (Löschel et al. 2010; Löschel et al. 2011).

## 7. Conclusive Summary

Recently, the market for EUA emission certificates has seen wide fluctuations. EUA prices followed a stable positive trend for about two years up to the end of 2015, reaching a level of around EUR 8.00 per tCO<sub>2</sub> in December 2015. Afterwards, the price experienced a sharp drop, plummeting to less than EUR 5.00 by February 2016. In spring 2016, it recovered slightly just to drop again to about EUR 4.50 after the Brexit vote.

Given the higher volatility of carbon markets, motives for trading EUAs have changed since last year's survey. Regulated companies name hedging as the new number one motive. In light of recent price developments, the surveyed firms have also adjusted their price expectations downwards for the near future (to EUR 6.71 for December 2016 and EUR 8.30 for December 2017). However, in the long term, price expectations remain on a high level (EUR 13 until 2020 and EUR 25 until 2030). Notwithstanding, prices are not surpassing the level which is deemed necessary to trigger substantial abatement activities (EUR 26).

Carbon abatement, although implemented by three quarters of firms, remains a side effect of abatement activities. Instead, abatement is implemented in order to reduce energy and raw material costs as well as to increase efficiency. The costs incurred due to the EU ETS today or likely in the future do not play a major

role as drivers of abatement activities.

Although the Paris Agreement was generally not seen as a major driver of recent price shifts, it was considered a major breakthrough in international climate action. The agreement may potentially strengthen market-based international climate policies, such as the EU ETS. However, uncertainties remain concerning the implementation of national policies conducive to the ambitious targets of the agreement. This might be a reason why the surveyed firms expect no (additional) long-term emissions reductions from the agreement. Likewise, they do not expect substantial changes to their competitiveness, employment, or relocation plans.

In retrospect, the EU ETS has proven to be main contributor limiting GHG emissions in the regulated sectors for more than ten years, while keeping costs on a low level. However, the scheme could be further strengthened to ensure the effectiveness and efficiency of climate action in Europe. We see some scope for improvement to ensure an efficient abatement pathway for long-term decarbonisation, for improving the reliability and transparency of the regulatory framework and the consistency between national climate policies and the EU ETS, and reducing administrative costs for regulated companies.



## 8. Appendix: Structure of the KfW/ZEW CO<sub>2</sub> Barometer – Carbon Edition

The KfW/ZEW CO<sub>2</sub> Barometer has been analysing the situation of German companies regulated under the EU ETS since 2009. The objective is to closely monitor firm behaviour in carbon markets in order to provide detailed information to policy-makers, businesses and the research community. The survey addresses a broad spectrum of topics related to company behaviour in carbon markets such as expectations regarding carbon and commodity prices, carbon trading strategies, abatement activities and impacts of the regulatory framework on companies' competitiveness.

Almost all German companies regulated under the EU ETS were invited to participate in the survey in March and April 2016. Only one person responsible was contacted per company in order to avoid contacting a company multiple times. This is particularly important, as almost 38 % of the contacted companies monitor more than one installation regulated under the EU ETS. In 2016, the population of the survey was a sample of 825 companies, of which 687 were contacted (the remaining companies had stated in previous years that they did not wish to be contacted again) and 118 responded to the questionnaire, which corresponds to a response rate of 14 %. Emission data from the Community Independent Transaction Log (CITL) and the European Union Transaction Log (EUTL) were aggregated and merged with the responses. Table 3 summarises the response rates according to different dimensions.

**Table 3: Response rates**

	Population	Survey
Companies	825	118 (14 %)
Installations covered by firms	1,912	469 (25 %)
Verified emissions in 2014	444 Mio. tCO <sub>2</sub>	180 Mio. tCO <sub>2</sub> (40 %)

The number of installations and verified emissions are based upon data of EC (2016a) as of 1 April 2016. The slightly different figures reported in section 3 draw from updated data as of 2 May 2016.

Source: EC (2016a)

The participating firms operate around 25 % of the German installations and cause 40 % of the verified emissions. The type of activity that the CITL/EUTL data base includes does not allow conclusions about sector classification; therefore, the study surveyed the main goods or services produced by the firm. The surveyed

companies were asked to classify themselves according to their type of business. Forty-two per cent of respondents classified themselves as belonging to the energy sector (see Table 4).

**Table 4: Sector classification of responding firms (NACE)**

	NACE Rev.	Share
Energy and/or heat generation (e.g. power supply companies)	40.1	41.7 %
Food and animal feed, beverage industry	15	6.1 %
Textile, clothing, leather and leather goods	17, 18, 19	0.0 %
Pulp and paper, paper products, printing and publishing	21, 22	7.8 %
Manufacturing of coke, refined petroleum products and nuclear fuel	23	0.9 %
Chemical industry	24	13.0 %
Rubber and plastic products	25	0.9 %
Manufacturing of other non-metallic mineral products (glass, ceramics etc.)	26	13.9 %
Steel and non-ferrous metal production	27	5.2 %
Metal products	28	0.9 %
Manufacturing of machinery and equipment	29	0.0 %
Automotive industry (incl. suppliers)	34, 35	2.6 %
Office machinery, computers, electrical and optical equipment	30–33	0.0 %
Other	–	7.0 %

Source: Own survey

Furthermore, companies are categorised according to their emissions. Companies emitting less (more) than 25,000 tCO<sub>2</sub> are classified as small (large) emitters according to EU Directive 2009/29/EC. 64 % of the firms participating in this year's survey qualify as large emitters. The participation rate among large emitters was roughly 18 %, while just over 10 % of the small emitters participated in the survey.

In addition, the survey classifies the companies according to their size: small and medium enterprises (SMEs) and large companies. According to the definition of the European Union, SMEs are enterprises with fewer than 250 employees (EC 2003). This criterion for SMEs was met by 24 % of the participating firms. Sales revenues should in general be taken into account to distinguish SMEs from large companies. However, data on sales revenues could not be assessed for all participating companies. Therefore, this criterion was left out.



## References

- Acemoglu, D., Aghion, P., Bursztyn, L. and Hémous, D. (2012):** "The Environment and Directed Technical Change." *American Economic Review* 102: 131–166.
- Buchholz, W. and Heindl, P. (2015):** „Ökonomische Herausforderungen des Klimawandels.“ *Perspektiven der Wirtschaftspolitik* 16: 324–350.
- Deutsche Emissionshandelsstelle (DEHSt) (2016):** "Treibhausgasemissionen 2015 Emissionshandelspflichtige stationäre Anlagen und Luftverkehr in Deutschland (VET-Bericht 2015)", Berlin.
- Deutscher Wetterdienst (DWD) (2016):** "Deutschlandwetter im Winter 2015/16. Ein ungewöhnlich milder, oft sonnenscheinreicher Winter", [http://www.dwd.de/DE/presse/pressemitteilungen/DE/2016/20160229\\_deutschlandwetter\\_winter.pdf?\\_\\_blob=publicationFile&v=2](http://www.dwd.de/DE/presse/pressemitteilungen/DE/2016/20160229_deutschlandwetter_winter.pdf?__blob=publicationFile&v=2), accessed on 1 July 2016.
- Destatis 2016:** "Produktionsindex für das Verarbeitende Gewerbe", Table 42153, accessed on 8 June 2016.
- Ekardt, F. and Wieding, J. (2016):** "Rechtlicher Aussagegehalt des Paris-Abkommens – eine Analyse der einzelnen Artikel", *Zeitschrift für Umweltpolitik & Umweltrecht* 39: 36–57.
- European Commission (EC) (2003):** "Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises", notified under document number C(2003) 1422, May 2003, Brussels.
- European Commission (EC) (2015):** "Decision (EU) 2015/1814 of the European Parliament and of the Council of 6 October 2015 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC"
- European Commission (EC) (2016a):** "Union Registry of the EU ETS" [http://ec.europa.eu/clima/policies/ets/registry/-documentation\\_en.htm](http://ec.europa.eu/clima/policies/ets/registry/-documentation_en.htm), accessed on 30 June 2016.
- European Commission (EC) (2016b):** "Emissions trading: slight decrease in emissions in 2015", [http://ec.europa.eu/clima/news/articles/news\\_2016052001\\_en.htm](http://ec.europa.eu/clima/news/articles/news_2016052001_en.htm), accessed on 7 July 2016.
- Gallier, C., Heindl, P., Osberghaus, D., Brockmann, K. L. and Dieckhöner, C. (2015):** "KfW/ZEW CO<sub>2</sub> Barometer 2015 – Carbon Edition. Ten years of emission trading: strategies of German companies", <https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2015-Carbon-Edition.pdf>, accessed on 6 July 2016.
- Goulder, L. H. and Parry, I. W. H. (2008):** "Instrument Choice in Environmental Policy." *Review of Environmental Economics and Policy* 2: 152–174.
- Government Offices of Sweden (2016):** "Real emission reductions and more pressure on the EU due to new Swedish EU ETS policy", <http://www.government.se/press-releases/2016/07/real-emission-reductions-and-more-pressure-on-the-eu-due-to-new-swedish-eu-ets-policy/>, accessed on 12 July 2016.
- Heindl, P., Wood, P. J. and Jotzo, F. (2015):** Combining International Cap-and-Trade with National Carbon Taxes", in: Gronewald, M., Hintermann, B. (Eds.), "Emissions Trading as a Policy Instrument: Evaluation and Prospects." MIT Press, Cambridge (Massachusetts): 123–147.
- Heindl, P. (forthcoming):** "The impact of administrative transaction costs in the EU emissions trading system." *Climate Policy*. doi:10.1080/14693062.2015.1110108.
- Jotzo, F. (2012):** "Australia's carbon price." *Nature Climate Change* 2: 475–476.
- Löschel, A., Kiehl, K., Heindl, P., Lo, V., Koschel, H. and Koesler, S. (2010):** „KfW/ ZEW CO<sub>2</sub> Barometer 2010 Effizienzpotenziale des Emissionshandels noch nicht ausgeschöpft – Strategien und Management deutscher Unternehmen“, [https://www.kfw.de/Download-Center/Konzernthemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2010\\_d.pdf](https://www.kfw.de/Download-Center/Konzernthemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2010_d.pdf), accessed on 15 July 2016.

**Löschel, A., Brockmann, K. L., Heindl, P., Lutz, B. und Schumacher, J. (2011):** „KfW/ZEW CO<sub>2</sub> Barometer 2011, Hoher Anpassungsbedarf im EU-Emissionshandel ab 2013 – deutliche Defizite bei der Vorbereitung in den Unternehmen“, <https://www.kfw.de/Download-Center/Konzerntemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2011-LF.pdf>, accessed on 15 July 2016.

**Marcu, A. (2016):** „Carbon Market Provisions in the Paris Agreement (Article 6)“, ICCG Reflection No. 45, International Center for Climate Governance.

**Michaelowa, A. (2016):** „Marktmechanismen im Pariser Abkommen – Eckstein oder Nebenkriegsschauplatz?“, Zeitschrift für Umweltpolitik & Umweltrecht 39: 102-109.

**Neuhoff, K. et al. (2015):** Is a Market Stability Reserve likely to improve the functioning of the EU ETS? Evidence from a model comparison exercise, DIW 2015

**Nordeng, A., Schjølset, S., Ferdinand, M., Dimantchev, E., Marcello, T., Chai, H., Lee, H. and Kolos, M. (2016):** Thomson Reuters Carbon Market Survey 2016.

**Proelß, A. (2016):** „Klimaschutz im Völkerrecht nach dem Paris Agreement: Durchbruch oder Stillstand?“, Zeitschrift für Umweltpolitik & Umweltrecht 39: 58-71.

**Schenker, O. (2016):** „Die Klimaziele können nur erreicht werden, wenn die Kosten möglichst gering bleiben“, ZEWnews January/February 2016, p.12.

**United Nations Framework Convention on Climate Change (UNFCCC) (2015):** “Adoption of the Paris Agreement”, <https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf>, accessed on 5 July 2016.