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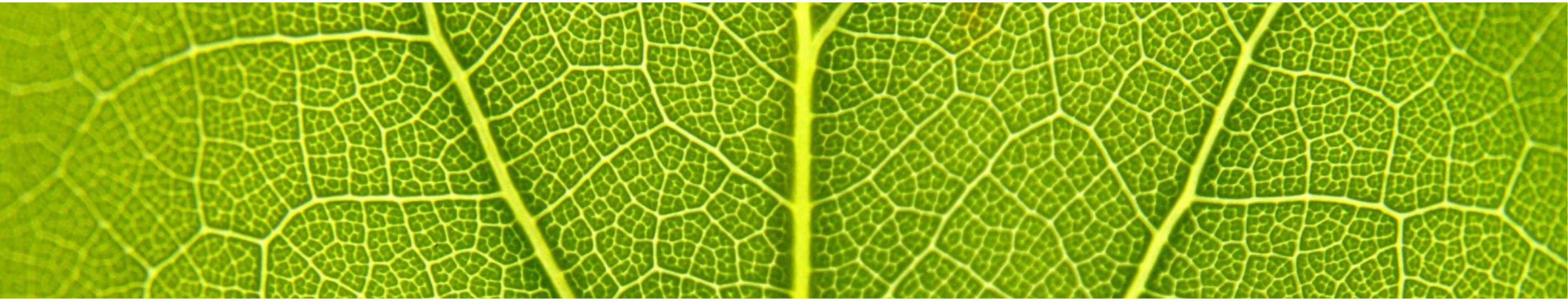

Allowance balance calculation in the EU ETS

Assessing the free allowance balance for various industrial sectors until 2030

10/05/2017

Ecofys by order of Fertilizers Europe

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Objective of this study and limitations

The main objective of this study is to **assess the surplus/shortage of free allowances** of various industrial **from 2008-2016** and **project** this **allowance balance**[1] to the end of phase IV of the European Emission Trading Scheme (EU ETS) in **2030.** Thereby, the underlying **premise of this study is** only work with **publicly available data.**

Limitations

- As only publicly available data was used for the calculations, **the study does not make a correction** for various detailed factors, such as **cross-boundary heat flows** or emissions from **combined heat and power (CHP) generation**
- However, the study maps such factors and **explains the potential impact of not correcting** the results for them accordingly
- This has been done in a qualitative way, and where possible, **substantiated by publicly available data**
- **The accuracy of the results** for the balance calculations in this study could be improved by performing an **extensive data collection on an installation level including corrections for the detailed factors.** However, data on such an aggregation level is not publicly available and it is expected that the **main conclusions of this study** would **remain the same**

The study aims to give an objective view on the allowance balance of the analysed sectors based on quantitative findings and a critical review of the results.

This study was conducted by the order of Fertilizer Europe.

[1] Throughout this study the term allowance balance refers to the accumulated surplus or shortage of **free** allowances, i.e. the amount of **free** allowances minus **direct emissions** for the time period under consideration

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Management Summary

1. On the basis of our analysis and assumptions in this study, we expect that **some sectors, such as fertilizers and iron & steel** have, **relative to other sectors, e.g. cement or paper and pulp**, a significantly **lower allowance balance.** The fertilizer sector already experiences an **impact from direct carbon cost** now.

2. This study shows that **fertilizers and iron & steel** are the only two of the seven assessed sectors **having a negative allowance balance** at the start of phase IV of the EU ETS. **All other** assessed sectors are expected to have **a positive allowance balance** for most of the next trading period.

3. Our analysis suggests that the **surplus of free allowances** of some sectors **cannot** only be explained by the **emission reduction efforts** of these sectors, but can be partially explained by some other **external factors**. These factors include, for example, a change of the activity level of a sector throughout phase III compared to its activity baseline used to determine free allocation levels or the relative performance of all installations of a sector against the benchmarks. Such factors potentially led to a **competitive disadvantage** for some sectors compared to others.

4. A sensitivity analysis on several input parameters, such as growth and emission efficiency improvements, shows that the **quantitative results can be seen as robust** and any corrections to the assumptions made would not be expected to alter the conclusions of this study.

5. The allowance balance is **affected by a range of other factors**, such as cross-boundary heat flows, and some of them potentially lead to an **upward or downward correction** of the allowance balance. Although, further research and data collections are needed to accurately account for them, the main conclusions from this study would most likely only be affected in terms of exact numbers and **not in their general tendency**.

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Background: How overallocation can be explained

A brief explanation of free allocation in the EU ETS phase III

Under the current EU ETS, installations which operate in sectors that are deemed to be at risk of carbon leakage receive free allocation up to a 100% of the benchmarked performance to compensate for the carbon cost impact. The amount of free allocation granted to such an installation is determined on the basis of historic activity (i.e. production levels) and a performance benchmark, i.e. the preliminary allocation, and reduction factors, such as a cross sectorial correction factor (CSCF).

How the allocation mechanism led to overallocation of some sectors

The historic activity level used to calculate the free allocation for 2013-2020 in most sectors is the activity level prior to the economic crisis in 2009. In the EU ETS phase III there is a mechanism to prevent overallocation in case the current production drops significantly compared to the historical activity level, also known as partial cessation. If the current activity level of a plant drops below a certain threshold the free allocation of this installation gets partially reduced. However, the thresholds for this partial cessation and closure rules where only set for a production decrease of 50% and 75%. This implies that an installation running at 51% of its historic activity level (and hence only emitting 51%) still receives the full compensation package for direct emission. This is what happened to a lot of installations in the EU ETS, especially to those in sectors who had a lot higher activity level prior the economic crisis in 2009. This led to a surplus of “unused” free allowances (overallocation), which can be banked and used in subsequent trading periods.

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Scope of the analysis

The selection of the sectors in this study is based on key emitting sectors in the EU ETS[1]:

NACE 4	Sector	Activity Codes[2]
20.15	Fertilizers and nitrogen compounds	38, 41
20.13	Inorganic Chemicals	-
20.14	Organic Chemicals	-
24.10, 07.10, 19.10 & 24.20	Iron & Steel	3, 4, 5, 22, 23, 24, 25
17.11 & 17.12	Pulp & Paper	35, 36
23.51	Cement	29
23.52	Lime & Plaster	30

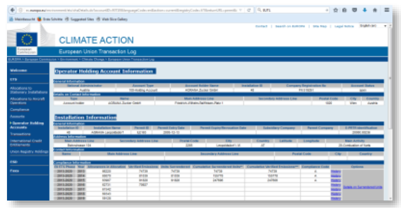
- The identification of installations in each sectors is **primarily based** on their **NACE 4** classification
- Installations under activity codes that belong to a sector subject to this study, but were not identified in the EC NACE code list as such, were added to the sector to improve the accuracy of the sector scopes in this study (see slide 12 for more explanation)
- For the chemical sectors, the activity codes in some cases did not match the NACE classification (i.e. some inorganic and organic companies report to the same activity code) and were therefore not used to determine the sector scope
- All results are derived and discussed on an sector-aggregated level
- The study takes closed installations into account, meaning that e.g. any surplus the closed installations had accrued over time are assumed to be for later use in the sector

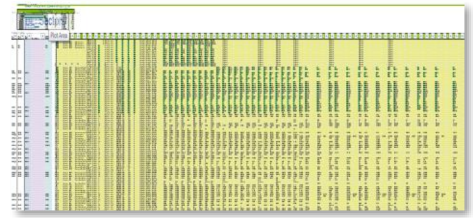
[1] Out of the key emitting ETS sectors, this study did not assess the refinery and extraction of crude petroleum industry, given the different complexities related to these sectors. In general, it is worth noting that comparable analyses could in principle be made for other sectors as well

[2] Each installation is assigned an activity code in the European Union Transaction Log (EUTL) specifying their main EU ETS production activity

Bird's-eye view of the methodology: Two main steps

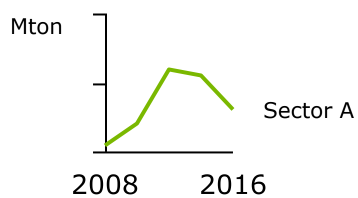
1 Data extraction & processing

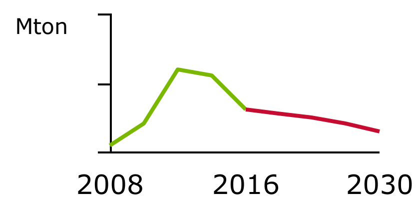




- Extraction of installation-level data from the EUTL
- Processing of data extraction, aggregation (sector matching) & quality review

2 Balance calculation & projection





- Calculating the allowance balance for each sector based on historic data
- Projecting the balance up to 2030
- Sensitivity analysis on assumptions

Procedures, key assumptions and their implications

Procedure / Assumption	Implication
Installations were primarily **matched to their sector by NACE 4 codes** based on the the European Commission's publication on the "*classification of installations in the EUTL Registry based on the NACE 4 statistical classification*"[1], and where applicable with the activity code	The NACE classification of the EC is from 2014 and for some installations the classification might be outdated. The **scope of the sectors** in this study **might be therefore different** from other, similar studies that use a different approach for identifying installations per sector
The emissions related to the **transfer of waste gases in the steel sector have been taken into account** in the balance calculation, as this information was publicly available[2]	The actual impact on **the steel sector allocation balance due to waste gas transfer could be slightly different** from our result as the waste gas data was only publicly available for 2014 and was scaled back for the previous years based on the steel sector emissions.
No other corrections for factors such as cross-boundary heat flows, inherent CO_2 or CHP generation were made, as this was not publicly & quantitatively available in a consistent manner for all sectors investigated	This might lead to an **over- and underestimation** of some results. However, the **factors potentially distorting** the balance calculation are **discussed** and **evaluated** in this study
The determination of projected allowances for phase IV is done **based on emission data as a proxy** instead of production data (see next slide for more details)	This implies the assumption that **emissions correlate perfectly with production** volumes. The implications are discussed and evaluated in this study.

[1] https://ec.europa.eu/clima/sites/clima/files/installation_nace_rev2_matching_en.xls

[2] http://www.ecofys.com/files/files/ecofys-2016-carbon-costs-for-the-steel-sector-europe-post2020-upjune2016.pdf

The math behind determining free allocation post-2020

The **free allocation 2021 – 2030** is calculated according to the following formula:

$$Allocation_{2021-2030} = Allocation_{Prelim,\,post\ BM} * CL\ compensation\ factor * CSCF$$

- Where, $Allocation_{Prelim,\,post\ BM}$ is the preliminary allocation from 2021 - 2030 before the benchmark update multiplied with the benchmark reduction value. In study, we used an **annual flat rate benchmark update of 0.5%** for phase IV for all sectors as the base case.
- We assume that all assessed sector will be on the CL list, i.e. a **CL compensation factor of 1**.
- In this study, we use the Council General Approach on the reform of the EU ETS and the **CSCF would be triggered in 2027** under a 0.5% benchmark update for all sectors. The average CSCF value over phase IV would be 0.92.
- The **Preliminary before the benchmark update** is extrapolated from the preliminary allocation in phase III of the EU ETS, i.e.:
  - Preliminary allocation 2021-2025 = Preliminary allocation in 2013 / (median (activity baseline 2005-2008)) x (median (activity baseline in 2013–2017))[1]
  - The preliminary allocation in 2013 = (Final free allocation in 2013 / CSCF in 2013).

The preferable choice for the activity baselines would be real production data from ETS plants. For a few sectors for which the NACE 4 scope and the ETS scope are a close match, EUROSTAT is a good source for this. However, for other sectors this is not the case, as NACE 4 production volumes also include production from non-ETS plants. This data would not accurately reflect the production in the ETS plants (see Appendix). For these sectors, the EU ETS emissions from EUTL would be the next best proxy to activity level.

To ensure a consistent approach across all sectors, this study therefore chose to approximate production data of sectors by using the emission data in the EUTL.

[1] The preliminary allocation for 2026-30 is calculated in the same fashion by taking he baseline of '18-'22 instead

Emissions as a proxy for production data

- A correlation check (see further details in the Appendix) of **NACE 4 level EUROSTAT production data** for the EU ETS countries with EUTL emission data revealed that it is **not serving as a good basis for the free allocation post-2020 calculations in many sectors**
- Instead, the starting point to **approximate the historic activity levels** is the assumption that **production and direct emissions for each sector perfectly correlate**
- To take major historical scope changes into account (e.g. the mandatory inclusion of fertilizer installations from 2013 onwards), we **back-casted the emission levels** for each sector from 2016 back to 2005 by **scaling up the emissions** to the phase 3 scope. This is necessary as the baseline for historic activity data is the median of 2005-2008, or in some cases 2009-2010
- The model calculation is also **able to account for historic emission intensity improvements,** which were set to 0% for the base case and tested for in the sensitivity analysis.
- Furthermore, **emissions are projected up to 2030** by applying an assumption for future annual production growth. Due to a lack of reliable public & sector specific data on emission intensity improvement projections, the future annual emission intensity improvements were set to 0%. Although the benchmark update (based on top 10%) is different from the sector average annual emission intensity improvement, by assuming a lower benchmark flat rate update value of 0.5%, the future intensity improvement assumption is better reflected.
- Finally, with future emissions and the projected allocation (see previous slide) the **allowance balance calculation** can be carried out **until 2030**

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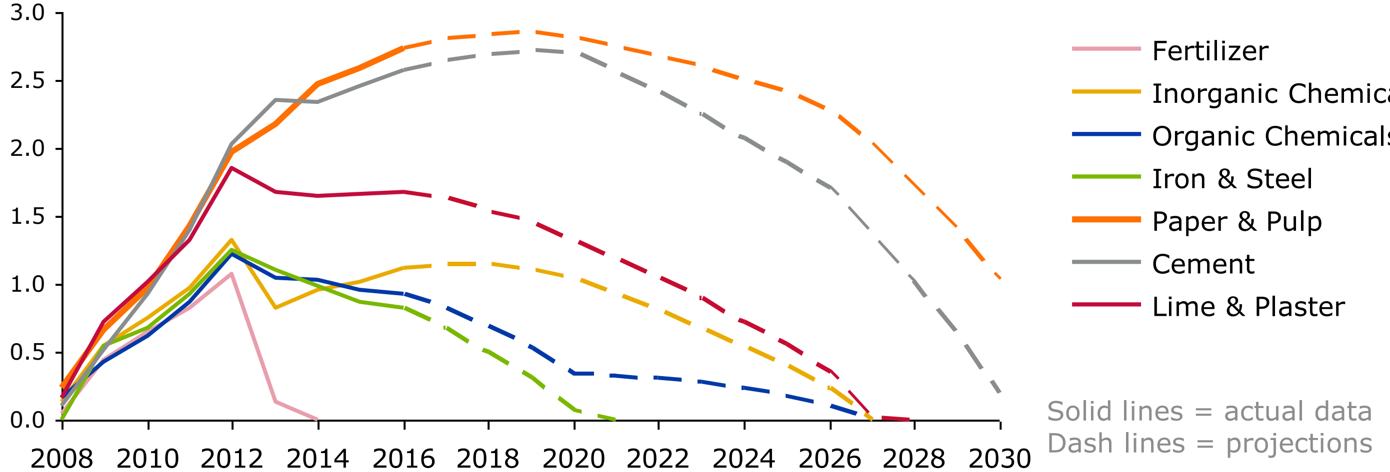
Main results (I/II)

Number of years that the surplus of free allowances covers[1]



- The graph indicates how many years a sector could cover its ETS emissions[2] in a specific year with the surplus of allowances built up over the previous years, starting from 2008 (i.e. the year from when allowances could be banked across phases)
- It shows that **most of the sectors assessed** have an **allowance surplus** that carries long into phase IV, in particular the paper & pulp and cement sectors
- In contrast, fertilizers already have a negative balance since the end of 2014
- The drop in surplus for some sectors post-2012 can be explained by **new allocation rules**, such as the use of benchmarks instead of historical emissions and excluding free allocation for electricity generation from waste gases (see more on subsequent slides)
- **Please note,** that these results should be taken only as indicative, as some factors influencing the results are not accounted for, **discussed in the subsequent slides**

[1] The results are shown for a base case. The detailed assumptions for the base case, i.e. 0.5% benchmark update for all sectors and the CSCF triggered in 2027. are given in the Appendix of this report
[2] Emissions refer to the actual (solid line) or projected emissions (dashed line) of the respective year

Main results (II/II)

Sector	Balance end of phase II[1] (Mton)	Balance end of 2016[1] (Mton)	Balance end of 2020[1] (Mton)	Balance end of 2030[1] (Mton)
Fertilizers and nitrogen compounds	11 [28%]	-9 [-24%]	-38 [-96%]	-139 [-353%]
Inorganic Chemicals	8 [58%]	12 [89%]	11 [83%]	-16 [-116%]
Organic Chemicals	59 [102%]	48 [85%]	17 [30%]	-64 [-111%]
Iron & Steel	202 [94%]	135 [63%]	11 [5%]	-571 [-265%]
Pulp & Paper	60 [166%]	75 [209%]	78 [215%]	24 [66%]
Cement	236 [158%]	297 [198%]	312 [209%]	-10 [-6%]
Lime & Plaster	51 [158%]	49 [151%]	39 [119%]	-43 [-131%]

[%] = Allowance balance relative to preliminary allocation in 2013, e.g. at the end of phase II, the allowance surplus for fertilizers was 28% of their preliminary allocation in 2013; all values in the table are rounded to whole numbers

- A negative balance indicates the amount of emissions that have to be purchased on the market additional to the free allocation received in that sector
- Comparable analyses could in principle be made for other sectors as well
- **Please note,** that these results should be taken only as indicative, as some factors influencing the balance are not accounted for, which **will be discussed in the subsequent slides**

[1] The results are shown for a base case, i.e. 0.5% benchmark update for all sectors and the CSCF triggered in 2027. The detailed assumptions for the base case are in the Appendix of this report

Factors explaining a positive or negative balance (I/III)

1. Production changes

If a sector increases or decreases the production levels compared to the baseline for the determination of free allocation, this naturally influences the allowance balance. For example, economic driven production decreases due to the crisis, which are above the partial cessation thresholds can explain to a great extent the allowance surplus of the cement and lime & plaster sector. This can be expected to be one of most important factors leading to the large positive allowance balance of some sectors. Based on the computed emission values serving as activity proxies in this study, the following table shows the relative production change from the median of 2005-2008 activity (used as the baseline to determine the phase III free allocation) to the average activity from 2013-2016.

Sector	Activity changes[1]: Median 2005-2008 vs Average 2013-2016
Fertilizers	-2%
Inorganic Chemicals	-19%
Organic Chemicals	4%
Iron & Steel	-12%
Pulp & Paper	-20%
Cement	-26%
Lime & Plaster	-12%

- If sectors would have had the same activity in 2013-2016 as the baseline used to determine the phase III free allocation, the surplus would be smaller for every sector except organic chemicals
- Assuming a constant 2013-2016 **activity level equal to the median of 2005-2008,** the surplus at the end of 2016 would be **59 Mton lower for steel** and **164 Mton lower for cement**

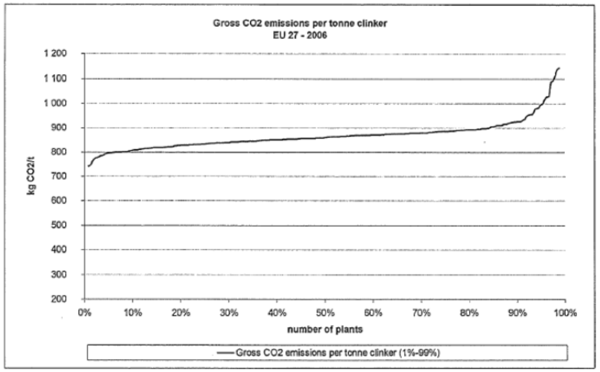
[1] **Please note,** numbers do not reflect real production volumes but are an approximation based on emission values, which do not take the actual historic emission intensity improvements into account as these were set to 0% for the base case. For example, it is known that fertilizers had a significant historic improvement in emission intensity from 2005-2013. Would this improvement be taken into account, the relative change for the production proxy would be smaller in absolute terms.
In general, the activity proxy of this study was checked against production statistics published by trade associations and found to be an appropriate approximation, even without the correction for historic improvements.

Factors explaining a positive or negative balance (II/III)

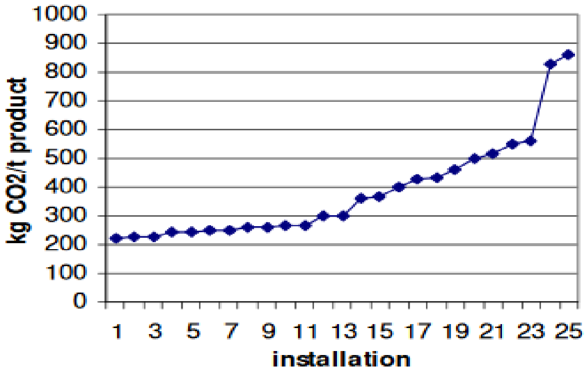
2. Methodological differences in the benchmark setting & steepness of the benchmark curve

The methodological approaches to set the benchmarks were not identical for all sectors. For iron and steel, for example, corrections were made for the use of waste gases for electricity production and some of the benchmarks (e.g. in the pulp and paper and iron and steel industry) were based on literature values or only a selection of installations. One can argue that different approaches for the benchmark setting implies that the strictness of benchmarks might vary across sectors, which would make it easier for some sectors to accumulate free allowances in their balance. This point is also closely linked to another aspect of the benchmarks influencing the allowance balance, namely the steepness of the benchmark curves of sectors.

Some sectors have a rather "flat" benchmark curve, for example for the clinker benchmark (see illustration bottom left) or for lime as the benchmark value is strongly determined by the process emissions that cannot be easily abated. This means that on average, the installations in these sectors are closer to the benchmark than in sectors with a steeper benchmark curve, and thus have fewer installations with a large shortage. The illustration on the bottom right (benchmark curve for low-heat resistant ceramic products) serves as an example for a rather steep curve.



Source: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-cement_en.pdf



Source: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-ceramics_en.pdf

Factors explaining a positive or negative balance (III/III)

3. Emission efficiency improvements

In some sectors, installations may have significantly improved their emission intensity, resulting in more free allowances than they need, which is in line with the intentions of the EU ETS to create financial incentives for emission efficiency gains. For example in the fertilizer sector, a significant emission efficiency improvement took place over 2005-2013 (almost 90%) in nitric acid production. However, the fertilizer sector were only included in the EU ETS from phase III onwards, with the exception of opt-ins in some countries in phase II, and were therefore unable to largely benefit from this efficiency improvement in terms of free allowances.[1]

4. Increased use of renewable fuels & electrification of processes

If sectors increase the share of zero-emission fuels, they end up with lower emissions reported under the EU ETS and increase their free allowance balance. Similarly, with the electrification of processes indirect emissions reported under the EU ETS go down. However, in the latter case the increasing surplus goes hand-in-hand with an increase in indirect emissions (and the associated costs).

Three main conclusions from our analysis:

- Our analysis suggests that some sectors which are deemed to be at risk of carbon leakage built up a large positive allowance balance, while other sectors that are also on the carbon leakage list did not
- According to our calculations, especially the cement sector as well as the pulp & paper industry accumulated a surplus of free allowances reducing their direct carbon cost impact in the next trading period under the assumptions in this study
- We also identified four factors that help to explain why sectors such as fertilizers were not able to build up a comparable allowance balance and hence are affected by direct carbon costs in a different way

[1] Despite the significant efficiency improvements in nitric acid production in the fertilizer sector, in phase 3 the fertilizer sector has an annual shortage as efficiency improvements in ammonia production has been limited (see slide 29 for further details)

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Critical Reflection of the Findings

When looking at the results and conclusions discussed in the previous slides, one has to take into account a range of factors that may require an adjustment of the allowance balance calculation as determined in this study, such as:

- Waste gas transfers (in the calculation, adjustments already made for the steel sector)
- Emissions from CHP
- Different treatment of the allowance balance of closed installations
- Cross boundary heat flows or inherent CO_2

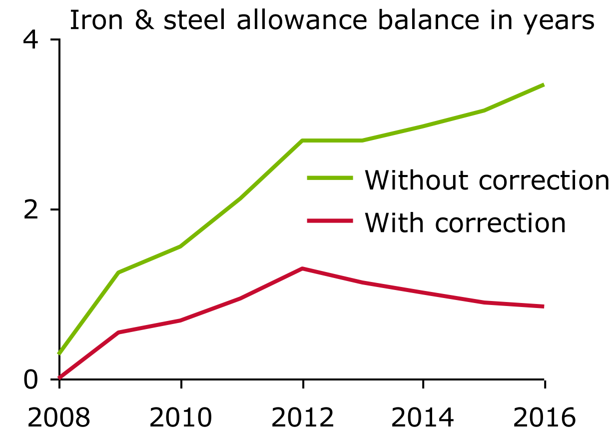
Neglecting these factors might lead to an over- or underestimation of free allowances or direct emissions of a sector as calculated from the EUTL extraction.

As it would require a detailed installation level data collection to incorporate these aspects accurately in the balance calculation and would be difficult to substantiate them with publicly available data the following slides will give a brief explanation to each of the factors listed above and give a judgement on their impact on the results of this study.

How waste gases affect the allowance balance

Explanation:

In some cases, waste gases of an ETS plant are transferred to another ETS plant where they are used as alternative or substitute fuels in order to produce heat or/and electricity. In such a case, not the transferring but the receiving plant, which might be reporting to another NACE 4 category, reports the emissions. However, if waste gas emissions are part of a sector's benchmark, they still receive free allowances for their emission.



Example:

For example, the steel sector transfers waste gases in large quantities to installations reporting to electricity-activity codes. The receiving plants generate electricity and emit the CO_2 from this waste gases, amounting to ca. 43 Mt/year. As the free allowances already account for these emissions & the steel sector compensates the electricity producers for handling the waste gases by handing over allowances, one can correct this factor by adding the waste gas emissions to the steel sector emissions. This was also done in this study as the required data was publicly available.

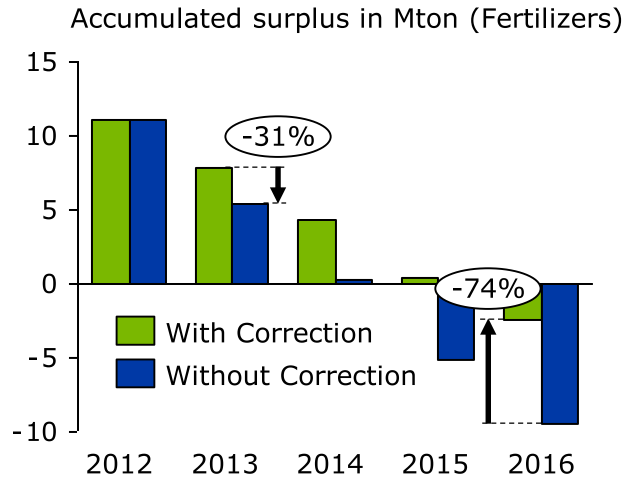
Implications for other sectors and the results:

The graph on the right shows the years worth of the allowance balance of the iron & steel sector with and without the correction for waste gases. As one can see that the correction has quite some impact. This issue is most likely most relevant for the steel sector, so we expect this factor to have a limited impact on the results for the other sectors assessed.

How CHP-emissions affect the allowance balance

Explanation:

Many installations of energy intensive industries in the EU ETS make use of CHP generation, as it is often an efficient way to produce process heat and electricity for the operation. As in the EU ETS phase III emissions from electricity are not compensated with free allowances, the argument is often made that emissions from electricity production should not be taken into account in a balance calculation.



Example:

In preparation for this report, the fertilizer sector provided us with a study containing data on CHP generation, revealing that direct emissions accounting for the electricity generation make up between 4-6%.

Implications for other sectors and the results:

For the results in this study, in none of the assessed sectors corrections for CHP electricity emissions were made, as there is no public, reliable data on CHP generation per sector. Although the correction could have a significant impact on the results (it leads to higher surplus / lower shortage as shown in the graph), the sector would still have to surrender emission allowances for these emissions. Hence, it was therefore chosen to not correct for this factor to apply a consistent approach across all sectors, but only illustrate the potential effect here.

How different treatment of allowances of closed installations affects the allowance balance

Explanation:

The calculation assumes that any surpluses in free allowances accrued over time are available for the sector, and any shortages are covered by other installations in the sector. This assumption may not be valid in case installations go through insolvency or bankruptcy.

Example:

The steel sector experienced several closures, in which the surplus of allowances accrued was not transferred for the use in other EU ETS installations in the sector:[1]

> SSI Redcar Steelworks entered liquidation in October 2015 and ceased all activities in Europe, building up a cumulative surplus of 16 Mton over 2008-2014. SSI does not hold any other steel plants in the EU ETS.

> Carsid / Duferco stopped their steel production activities in 2012 and accumulated a surplus of 15 Mton. These surplus allowances had to be sold to cover unemployment expenses.

Implications for other sectors and the results:

Most installations had a surplus in free allocation due to the economic crisis. If the surplus of closed installations would be excluded from the balance calculation, each sector may need to purchase allowances earlier than calculated in this study and would have a larger shortage / smaller surplus as the end of 2030. Since most large installations are owned by companies with multiple ETS installations and can thus transfer allowances between installations, the impact is considered to be limited on the main conclusions of this study.

[1] Examples from: Ecofys, *Carbon costs for the steel sector in Europe post-2020*, by order of EUROFER, June 2016

How cross-boundary heat flows & inherent CO_2 affect the allowance balance

Explanation:
In general, a mismatch between emissions and allocation in the EU ETS occurs when the emitting installation does not receive the allocation or vice versa. This is the case for transfer of heat and inherent CO_2

Example:
A typical case for transfer of heat and inherent CO_2 occurs in the chemical industry. For example, an exothermal production processes (i.e. production of formaldehyde), receives free allocation for exothermal heat based on a heat benchmark if the heat is delivered to another ETS installation (paper mill). At the same time, the emissions stemming from the production process are transferred to a nearby combustion installation as an alternative fuel. Combustion installations in larger industrial parks are mostly also subject to ETS and have to report their emissions based on activity data. In this case, the emissions of the chemical production facility are reported by the nearby combustion installation while the facility receives free allocation for the production. At the same time, the salt plant receives free allocation for consuming the heat, but does not need to report the associated emissions.

Implications for other sectors and the results:
This factor can only be accounted for correctly if collecting information on an installation level. In most sectors, e.g. steel, cement and fertilizer, the cross-boundary heat flows do not occur or the emissions occur irrespectively of heat transfer (e.g. waste heat). In other sectors, e.g. paper, cross-boundary heat flows from CHPs could explain a part of their surplus with this study overestimating their surplus. However, in many cases, these CHPs are already classified under the NACE code of the sector they supply heat to if that is their main activity. For inherent CO_2, this only applies to a limited part of the chemical sector. The impact of cross-boundary heat flows and inherent CO_2 on the result of this study is therefore expected to be limited.

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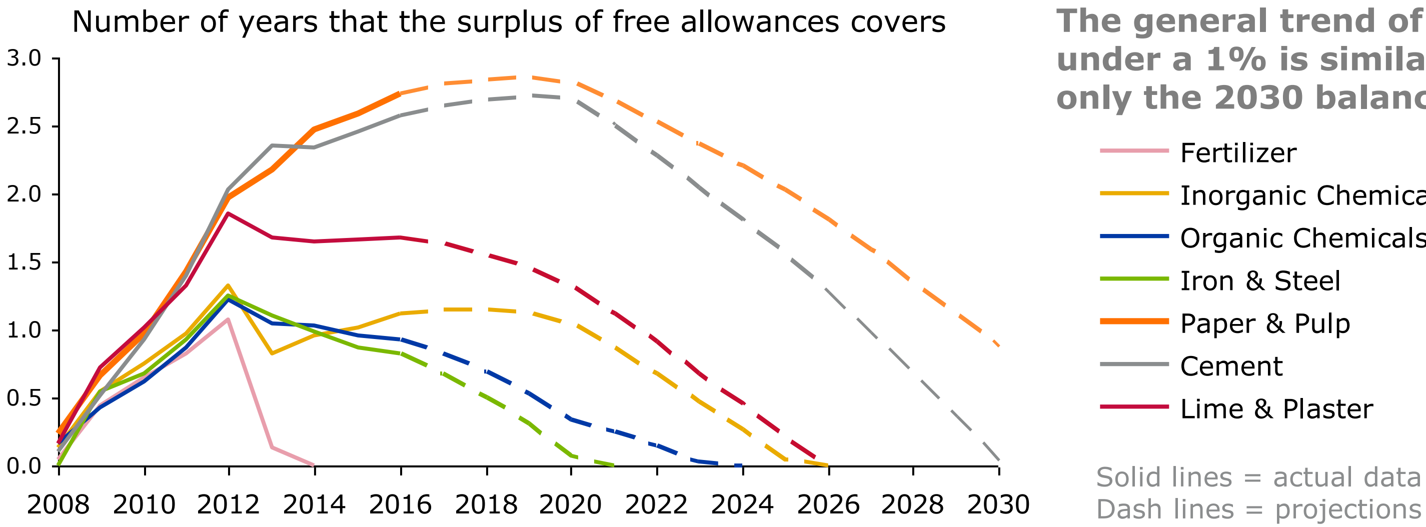
Findings of the sensitivity check (I/III) – Robustness of the findings

- All results in this report are shown for a base case, with underlying assumptions that can be found in the Appendix
- To check how sensitive the results of our approach are to these assumptions a calculation was also based on less conservative assumptions (i.e. higher historic and future emission intensity improvements, lower growth rates)
- Various scenarios where assessed testing the sensitivity of different historical emission intensity improvements of some sectors
- Overall the main conclusions do not change, however the projected balances in 2030 differ in exact numbers as, for example, lower growth assumptions towards 2030 lead to an increase of the allowance balance for every sector and vice versa.
- The following two examples illustrate the robustness of the overall findings:
  - The emission intensity for nitric acid production reducing from 1.88 t CO_2-eq/t HNO_3 in 2005 to 0.23 t CO_2-eq/t HNO_3 in 2013, equivalent to an emission reduction rate of 19% per year. Given that the nitric acid production accounts for a significant part of the fertilizer sector's emissions, this means the fertilizers sector's emission intensity overall fell substantially. Assuming constant production volumes for nitric acid and ammonia over the years, and no improvement rate for ammonia, this would be equivalent to an annual improvement of around 5% for the overall sector. Assuming a historic annual improvement (2005-2015) for the fertilizer sector of 5% in stead of 0% per year, which is reflecting the actual development much better, leads to an improvement of the allowance balance in 2030 from -139 Mton to -132 Mton
  - Increasing the projected annual growth (2021-2030) for steel from 0.5% as in PRIMES to 1.15% per year, corresponding to the growth rate of the steel 2050 roadmap by BCG/VDEh, leads to an decrease of the projected allowance balance from -571 Mton to -650 Mton. (If the mechanism of additional free allowances for significant production increase in phase IV as proposed by the European Commission is taken into account, the reduction of the projected allowance balance would be less)

Findings of the sensitivity check (II/III) – Impact of the annual BM flat rate update on the results

- The fertilizer sector had significant emission intensity improvements in nitric acid production of 19% per year over 2003-2013, resulting in an average emission intensity of 0.232 t CO_2-eq/t HNO_3 in 2013 against the benchmark of 0.302 tCO_2-eq/t HNO_3 set for phase III. This improvement would result in a more stringent annual benchmark reduction than the 0.5% in the base case. As the Council General Approach limits the annual benchmark reduction to 1.5% in order to "preserve emission reduction incentives", the sensitivity analysis accounted for the more stringent benchmark reduction as follows:
  - If a stricter benchmark reduction of 1.5% is applied to the whole fertilizers sector, this translates to a benchmark value of 0.234 tCO_2-eq/t HNO_3 for the period 2021-2025 and 0.211 for the period 2026-2030, (reduction of 22.5% and 30% compared to the phase III benchmark respectively)
  - Our model calculation shows that in this case the 2030 allowance shortage of -139 Mton would grow to -199 Mton. To put this into perspective, this delta of 60 Mton corresponds to about 160% of the total emissions the sector had in 2016
- However, the ammonia production data, the other product with significant volume in the fertilizer sector, showed that there was practically no improvement to the benchmark, which would correspond to a flat rate update of 0.2% under the Council General Approach. With nitric acid and ammonia production about equal, the fertilizer sector's average annual benchmark update would most likely be 0.5-1%.
- Ultimately, it is worth noting that the assumptions for historic emission intensity improvements do not affect the calculation of allowance balance until the end of EU ETS phase III, as this balance is only computed based upon real data from the EUTL and projected future emissions (future allocation is also known up to 2020). Even with the average performance of nitric acid plants being better than the phase 3 benchmark, the fertilizer sector already faces a shortage from 2014. Historic improvements are only used to correct for the activity proxy for 2005-2008 as this timeframe is used to scale-up the preliminary free allocation of phase III to phase IV (see slide 13).

Findings of the sensitivity check (III/III) – Results under a 1% BM flat rate update in phase IV



The general trend of the surplus under a 1% is similar to 0.5% and only the 2030 balance is difference

Sector	Balance end of phase II[1] (Mton)	Balance end of 2016[1] (Mton)	Balance end of 2020[1] (Mton)	Balance end of 2030[1] (Mton)
Fertilizers and nitrogen compounds	11 [28%]	-9 [-24%]	-38 [-96%]	-145 [-369%]
Inorganic Chemicals	8 [58%]	12 [89%]	11 [83%]	-18 [-128%]
Organic Chemicals	59 [102%]	48 [85%]	17 [30%]	-73 [-127%]
Iron & Steel	202 [94%]	135 [63%]	11 [5%]	-601 [-279%]
Pulp & Paper	60 [166%]	75 [209%]	78 [215%]	19 [53%]
Cement	236 [158%]	297 [198%]	312 [209%]	-26 [-18%]
Lime & Plaster	51 [158%]	49 [151%]	39 [119%]	-47 [-144%]

[%] = Allowance balance relative to preliminary allocation in 2013; all values in the table are rounded to whole numbers

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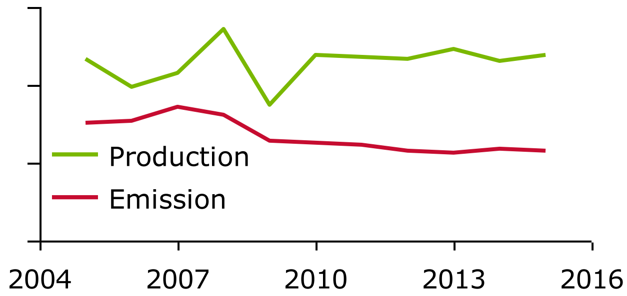
Detailed assumptions for base case calculations

Parameter	Assumption	Implication/Reasoning
CSCF	Triggered in 2027, 0.92 average over phase IV	Calculations are based on the Council's General Approach and the Ecofys E3C3 model, taking the flexibility into account to increase the free allocation pot by 2% of the phase IV cap.
Annual flat rate benchmark update	0.5%	This is based on various large emitting sectors stating no or limited emission improvements, while in some smaller sectors larger efficiency improvements were possible. Due to a lack of publicly available data and to take both effects into account, 0.5% is assumed for all sectors
Compensation Factor	1	We assume that all NACE codes assessed in this study will be recognised as carbon leakage
Future growth rates	Based on Primes[1]	One consistent source for all sectors, based on sector value added as production growth rates are not available.
Historic average emission intensity improvement	0% for every sector	There is no reliable public & sector specific data on historic improvement rates. Additionally, assuming no historic improvement most likely leads to an overestimation of the activity baseline (2005-2008), which in turn leads to a lower "up-scaling" of the free allowances in phase IV. This would lead to a downward adjustment of the allowance balance, but is expected to have a limited impact on the results of this study.
Future average emission intensity improvement	0% for every sector	There is no reliable public & sector specific data on improvement projections. Assuming higher improvement rates would result in an upward adjustment to the allowance balance, but is expected to have a limited impact on the results of this study.

[1] See https://ec.europa.eu/energy/sites/ener/files/documents/20160713%20draft_publication_REF2016_v13.pdf

Why production data was not used in this study



- The graph qualitatively shows how the EUROSTAT data relates to emission data in the example of lime & plaster. Especially in the period from 2005-2010 the connection of production and emission is incomprehensible

- The table below shows the correlation coefficients of EUROSTAT production data and the emission data of the EUTL extract for different timeframes. For a perfect correlation one would expect a positive coefficient close to one. However, the data suggests that the scope differences between EUROSTAT and EUTL are too big
- The limited or weak correlation is mainly due to the different scope of EUROSTAT and EUTL, as non-ETS plants also report their production volumes for each NACE code
- To have one concise source for activity data emissions from the EUTL extract was chosen as a proxy. The activity trends where checked against the statistical production data published by trade associations of the assessed sectors and found to be an appropriate approximation

NACE4	Correlation '13-'15	Correlation '05-'12	Correlation '05-'15
2013	-0,4950917	0,371145525	0,09942207
2014	0,984621575	-0,820465378	-0,862119019
2410	NA	NA	NA
1711	0,73224199	0,809660384	0,806807942
1712	NA	NA	NA
2351	0,577070218	-0,926259274	-0,931447008
2352	-0,076010598	0,607844068	0,620586732
2313	NA	NA	NA

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