ANALYSIS OF THE POSSIBLE USE OF BENCHMARKS FOR THE ALLOCATION OF ALLOWANCES IN THE HUBEI PROVINCE PILOT ETS AND THE RELEVANCE FOR A NATIONAL CHINESE ETS

A report by Wuhan University and the Center for Clean Air Policy (CCAP)

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December 2013
Analysis of the possible use of benchmarks for the allocation of allowances in the Hubei Province pilot ETS and the relevance for a national Chinese ETS
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Analysis of the possible use of benchmarks for the allocation of allowances in the Hubei Province pilot ETS and the relevance for a national Chinese ETS

1. Introduction and executive summary

This research paper has the principle goal of outlining short- and longer-term options for the Hubei province in China to implement the use of benchmarks as an allocation methodology under its pilot emissions trading system (ETS). This paper examines whether a benchmarking allocation method modelled after the European Union (EU) ETS can be implemented under the Hubei ETS, as well as both the short- and longer-term options for the deployment of such a system. This includes the proposal of some alternative benchmarking approaches that could be more straightforward to implement in Hubei province. Particular attention goes to the data acquisition for the development of benchmarks. Detailed data acquisition procedures are provided in this paper’s Annex. While, in principle it is conceivable that an EU ETS benchmarking approach can be developed in Hubei province within 2-3 years, this paper specifically highlights the need for installation-level data as opposed to the current company-level pilot ETS system in Hubei. This paper also briefly touches upon how benchmarks could be implemented in two key sectors in Hubei province: cement and power. We finally conclude this paper by looking toward the development of a national Chinese ETS and how its design can be influenced through benchmarks being developed in Hubei province. We also consider hypothetical future Chinese ETS design options and how these might inform implementation measures at the provincial level, including the need for developing benchmarks.

We start this paper by introducing the concept of benchmarking and the multiple benefits its can have as an allocation tool under an ETS (Chapter 2).

In Chapter 3, we introduce the EU ETS over the current period (2013-2020) and how it fits within overall EU climate policy and targets. We explain the allocation methodology under the EU ETS in the period 2013-2020 and elaborate on the method used to develop and implement benchmarks.

In Chapter 4, we set out to develop possible short- and long-term options for the use of benchmarks under the Hubei province pilot ETS. We start by giving an introduction to the current design followed by a list of options for implementing benchmarking as an allocation methodology in later stages of the pilot ETS.
In Chapter 5, we focus in particular on the cement and power sectors as examples of how benchmarking can be developed in practice.

In Chapter 6, we conclude by listing the possible relevance of the Hubei ETS pilot towards a forthcoming national Chinese ETS after 2015. We conclude by highlighting possible design options for this nationwide system and how it relates to provincial level implementation, including the use of benchmarks.

2. Benchmarking as allocation methodology

2.1 What is benchmarking?

Benchmarking is the process of comparing certain performance metrics of a company or installation to the best available practices of similar companies or installations. The concept of benchmarking is widely used across a range of sectors. One of the most famous benchmarks currently used is the Solomon Index in the refining sector. This benchmarking concept was developed more than 20 years ago by the consultancy Solomon Associates for assisting the auditing of economic and other performance indicators in the oil refining sector.

The concept of benchmarking began its use as a policy tool to improve energy efficiency in industrial sectors. Both the Netherlands and Belgium introduced a “benchmarking-convenant”, a voluntary agreement between the government and energy-intensive industrial sectors. Under this agreement, the industrial companies committed themselves to be at least as energy efficient as the top 10 percent most efficient production installations within their sector on a global scale. Here, the benchmarking metric is expressed as the energy use per unit of product produced.

For the purpose of this paper, we will look at CO2 benchmarks expressed as the amount of CO2 emissions per unit of product, which are a de facto derivative of the aforementioned energy benchmarks for non-process-related CO2 emissions. In particular, we will look at the use of benchmarking as a methodology to allocate allowances under an ETS.

Benchmarks have been applied since the beginning of the EU ETS in 2005, though initially only in certain countries. In particular, the Dutch and Flemish governments linked voluntary energy benchmarks to an allocation method under the first two EU ETS trading periods in 2005-2007 and 2008-2012. The British government introduced the use of benchmarks for allocations to new companies or installations entering the trading system after the start of a trading period.

The importance of benchmarking has increased dramatically under the EU ETS. Starting in 2013, benchmarking has become the default methodology for free allocation of allowances under the EU ETS. In Chapter 3 of this paper, we give a detailed description of how benchmarks are currently used under the EU ETS.

In the next part we will highlight the advantages of using benchmarks as an allocation methodology. We will explain the way in which benchmarks are currently used under the EU ETS including the guiding principles of their development.
2.2 Advantages of benchmarking in an emissions trading system

2.2.1 Introduction

In a cap and trade system such as the EU ETS or the Hubei ETS, there are limited choices on how to distribute allowances into the market in a fair and transparent manner. There are three methodologies that are considered most frequently under different forms:

- Auctioning of allowances
- Free allocation based on historical emissions, also known as “grandfathering.”
- Free allocation using an emissions benchmark multiplied by historical production.

It is also possible to apply a combination of the above methodologies when designing an ETS, as is the case in the EU ETS.

Furthermore, all of the above options may include additional factors to correct the actual allocation, in particular to make the sum of bottom up allocations meet a pre-set top-down overall cap.

In this part we will compare a pure grandfathering-based approach with an allocation that uses a benchmark to demonstrate that the benefits of using a benchmark-based allocation.

2.2.2 Rewarding “Early Action”

The main benefit often attributed to a benchmark-based allocation is that it rewards - or at least not punish - so-called “early action” by companies. We define early action as operational, technological and/or technical investments or changes to a production installation that have happened before climate policy, such as an ETS, has been implemented.

As an example, we introduce two almost identical fictional companies (A and B). These companies produce the same product at the same volume (100 units). The only difference is that Company A already has implemented reduction measures leading to a CO₂ intensity of 0.9 t CO₂/unit of product. Company B still is producing 1 t CO₂/unit of product.

Since both companies produce 100 units of production, the historical emissions of company A are 90 and those of company B stand at 100. Total emissions equal 190.

Table 1. Company Emissions Performance for a Unit Product

<table>
<thead>
<tr>
<th>Performance CO₂/unit product</th>
<th>t CO₂</th>
<th>Production (units of product)</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>0.9</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Company B</td>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
If we apply a pure grandfathering-based allocation method without correcting for a declining emissions cap, Company A would receive 90 allowances (for one year) and Company B would receive 100. It can be argued this is an unfair advantage for company B since it still can make emission reduction at least up to the level of the emissions of Company A and sell the resulting surplus of allowances. Company A, on the other hand, misses the financial opportunity and benefit that Company B received by waiting to implement emission reduction measures.

**Table 2. Company Emissions Comparison**

<table>
<thead>
<tr>
<th>Pure grandfathering</th>
<th>Historical emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>90</td>
</tr>
<tr>
<td>Company B</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>190</td>
</tr>
</tbody>
</table>

The situation can be even more disadvantageous for Company A if the grandfathering-based allocation is uniformly corrected to stay under an overall cap. If we assume this cap to be 180 (i.e. 10 less than in a pure grandfathered allocation scenario) then both Company A and Company B face a correction factor of around 0.95. This leads to a corrected allocation for Company A of 85 and for company B of 95 allowances.

In this case, Company A will have to employ deeper and more expensive emission reductions, or purchase allowances from Company B which resort from measures Company A has already taken itself. In this case, Company A is punished for being proactive in implementing emission reduction measures.
Table 3. Emissions Comparison with a Correction Factor

<table>
<thead>
<tr>
<th>Grandfathering with correction</th>
<th>Historical emissions</th>
<th>Correction factor</th>
<th>Corrected emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>90</td>
<td>0.9474</td>
<td>85</td>
</tr>
<tr>
<td>Company B</td>
<td>100</td>
<td>0.9474</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>190</td>
<td></td>
<td>180</td>
</tr>
</tbody>
</table>

If we instead apply a benchmark-based approach (under a total cap of 180 as in the previous example) and allocate allowances using a benchmark set at the most efficient installation (in this case, Company A) multiplied by the historical production (in this case 100 units for both Companies A and B), the result seems more fair through honouring historical emissions reduction measures that have been taken. The allocation for Companies A and B will stand at 90. In this case Company B will have to reduce emissions to stay under the cap (or purchase the equivalent amount of allowances) and Company A can benefit from its previous investments without implementing additional emissions reduction measures.

Table 4. Application of a Benchmark-based Allowance Allocation

<table>
<thead>
<tr>
<th>Benchmarking based allocation</th>
<th>Performance (t CO₂/unit of product)</th>
<th>Benchmark (t CO₂/unit of product)</th>
<th>Production (units of product)</th>
<th>Allocation (benchmark x production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>0.9</td>
<td>0.9</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Company B</td>
<td>1</td>
<td>0.9</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>180</td>
</tr>
</tbody>
</table>

The above simplified example demonstrates the power of a benchmarking-based allocation if policy makers seek to not unfairly advantage or disadvantage companies that have been inactive or proactive, respectively, in regards to the implementation of mitigation measures.

2.2.3 Information for companies

Aside from offering a more equitable approach to allowance allocation, the development of greenhouse gas (GHG) intensity benchmarks can provide useful information for the companies involved. The resulting benchmark curve will show participating companies how their GHG intensity compares to that of their
competitors. This is a concrete piece of information that allows companies to independently assess the potential to implement additional technical, operational and technological measures. Especially if climate policies such as an ETS implement more ambitious caps over time, the performance on a benchmark curve will become a significant indicator for the competitive performance of a company.

Beyond supporting GHG emissions reductions, benchmarking can support economic competitiveness. This is because (most of) the GHG benchmarks are directly derived from energy values through the relevant emission factors for the fuels used. For energy-intensive companies, such as most of the companies covered by the EU ETS or the Hubei ETS, understanding how their specific energy use compares to their competitors is highly economically relevant information.

Figure 1. Example benchmark curve showing CO₂ intensity

2.2.4 Information for policy makers

Policy makers also gain relevant information from the development of benchmarking curves, which are a good indication of the mitigation potential in key economic sectors. This is a relevant tool to assess the stringency of the caps or allocations being set for these sectors. In practice, the results of a benchmarking curve can be compared with the overall absolute or intensity-based targets introduced at an economy wide level, which then inform policy makers how much a particular sector may contribute to the overall mitigation goal.
3. Free allocation in the EU ETS using benchmarks

3.1 Introduction to European Climate targets and the EU ETS

3.1.1 Scope of the EU ETS

The main participants in the EU ETS are the European power sector and large industrial installations. In total, this system covers around 13,000 installations in the 27 European Member States, with annual emissions between 1.8 and 2 million tonnes of CO₂-equivalent.

The annex to the EU ETS lists all the installation types covered by the EU ETS starting on January 1st, 2013.

There are three ways in which Industrial installations are covered by the EU ETS, if they meet at least one of the following conditions:

- They combust fuels in installations with a total rated thermal input exceeding 20 MW (except in installations which incinerate hazardous or municipal waste)
- They are mentioned as a specific industrial sector or activity (e.g. refining of mineral oil or production of primary aluminium)
- They are mentioned as a specific sector or activity that meets a certain capacity or production threshold (e.g. production of Pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour)

The following important sectors are not covered by the EU ETS:

- The transportation sector (with the exception of the aviation sector)
- The agricultural sector
- The public and private building sector

The EU ETS sectors were defined as mentioned above due to both practical and historical reasons. First, the EU ETS, with around 13,000 installations in 27 Member States, covers nearly 50 percent of Europe’s GHG emissions, implying that the scope of the EU ETS achieves a practical optimal policy goal of having a significant proportion of the EU emissions covered while at the same time ensuring the system is administratively manageable. Second, the scope of the EU ETS was based on an older European regulation for Integrated Pollution Prevention and Control (IPPC) for large industrial installations. Using a similar, though broader, scope from existing environmental legislation facilitated the implementation of the EU ETS in 2005.

3.1.2 Europe’s 2020 targets for the EU ETS and non-EU ETS sectors

To understand the context in which the EU ETS operates, we will next provide a short overview of how Europe’s 2020 climate targets have been set.

In January 2008 the European Commission presented new legislation that set the emission reduction targets for sectors covered by the EU ETS, as well as for sectors not subject to the EU ETS. The European Parliament and European Member States approved this legislation in December 2008. These targets were set as follows:
• 21 percent reduction for EU ETS sectors by 2020 compared to 2005 emission levels
• 9 percent reduction for non-EU ETS sectors by 2020 compared to 2005 emission levels

Both targets combined lead to a 20% economy wide reduction target for the European Union by 2020 compared to 1990 baseline emissions.

The use of both a 2005 baseline for the EU ETS and non-EU ETS 2020 targets and a 1990 baseline for the EU’s economy-wide target may seem a bit inconsistent. The main reason for this split in base-year use is because, prior to 2005, no high-quality verified data existed for the EU ETS sectors. 2005 was the first year of the EU ETS and therefore the first year for which the EU Member States had verified and reliable emission reports from the installations that were covered by the EU ETS.

For both the EU ETS and non-EU ETS sectors, targets or caps are set over an eight-year period starting on January 1\textsuperscript{st}, 2013 and running until December 31\textsuperscript{st}, 2020.

The EU ETS EU-wide quantity of allowances issued each year starting in 2013 shall decrease in a linear manner beginning from the mid-point of the period from 2008 to 2012.

The quantity shall decrease by a linear factor of 1.74 percent compared to the average annual total quantity of allowances issued by Member States in accordance with the Commission Decisions on their national allocation plans for the period from 2008 to 2012. The 1.74 percent represents a fixed amount of allowances (37.44 Million tonnes CO\textsubscript{2}-eq) that each year is deducted from the cap of the previous year.

The table below shows the annual caps for both the EU ETS and non EU ETS sectors in the period 2013-2020. For the EU ETS, the amount of EU allowances (EUAs) issued starts at 2.039 billion in 2013 and goes down to 1.777 billion in 2020. For the non-EU ETS sectors the target in 2013 is 2.892 billion tonnes of CO\textsubscript{2}-eq and goes down to 2.733 billion tonnes in 2020.

Figure 2. EU ETS, non-EU ETS, and total EU GHG targets in period 2013-2020 (Mt CO\textsubscript{2}-eq, excl. aviation, LULUCF

While the EU ETS caps are set in the EU EUTS directive/legislation on an economy-wide basis for the entire European economy, the targets for the non-EU ETS sectors are split up between the 27 EU Member States. The EU Member States individual reduction targets were set using the simple metric of gross domestic production.
product (GDP) per capita in 2005. The figure below shows that EU Member States with a high GDP/capita have a more ambitious 2020 target than the ones with a lower GDP/capita.

Figure 3. Percent reduction of GHGs to 2020 target by country and GDP per capita

3.1.2 How are EU allowances allocated in the EU ETS as of 2013?

In the previous chapter, we explained how the overall cap on EU ETS emissions is set in the period 2013-2020. Moving from an overall economy-wide (or ETS-wide) cap to the installation level allocations require a few technical steps. We outline those steps below.

a) Step 1: Determine the share of the total allowances to be sold via action, allocated to industry or set aside for new entrants. In the first two phases of the EU ETS (i.e. 2005-2007 and 2008-2012) most allowances were allocated for free. This changes significantly in the third phase of the system (2013-2020). Beginning in 2013, the electricity sector will have to purchase all its allowances through auctioning or on the secondary market. A portion of the allowances needed by other industrial sectors will also be distributed via auction.

In addition, beginning in 2013, a portion of the allowances under the EU ETS cap that will be auctioned and a part that will be allocated to the industrial (non-power) sectors through the benchmarking scheme. A third portion of all allowances is set aside to create a reserve for new entrants, set at 5 percent of the total amount of allowances. New entrants are new installations or extended installations that enter the EU ETS after 2012.

The division between the amount of allowances to be auctioned and the allowances to be allocated to the industrial sectors is based on the share of the historical verified emissions between the two sectors (i.e. power sector and industrial sectors) in the period 2005-2007.
For each year in the trading period (2013-2020) the aforementioned division is corrected downwards with the 1.74 percent linear reduction.

The auctioning of allowances is guided through specific EU regulation and will be executed through three to four different auctioning platforms across Europe.

b) Step 2: Determine the list of industrial sectors exposed to carbon leakage and the amount of free allowances per sector.

The default rule for industrial sector installations is the free allocation of allowances based on a sectorial benchmark and historical production. We will come back to this specific allocation method in detail in the next step.

- The level of free allowances will differ among industrial installations based on different levels of exposure to the risk of carbon leakage. For installations in sectors or sub-sectors where there is no risk of carbon leakage, the amount of free allowances allocated in 2013 shall be 80 percent of the quantity allocated using benchmarks. Thereafter the free allocation shall decrease each year by equal amounts so that 30 percent of allocations will be free in 2020, with the goal of reaching no free allowances in 2027.
- For installations in sectors or sub-sectors which are exposed to a significant risk of carbon leakage, the amount of allowances allocated free of charge shall be 100 percent of the quantity allocated using benchmarks, in 2013 and in each subsequent year up to 2020.

The table below lists the “carbon leakage factors” (CLF) over the period 2013-2020 as mentioned above.

Table 5. EU ETS carbon leakage factors

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant risk for carbon leakage</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No significant risk for carbon leakage</td>
<td>0.8000</td>
<td>0.7286</td>
<td>0.6571</td>
<td>0.5857</td>
<td>0.5143</td>
<td>0.4429</td>
<td>0.3714</td>
<td>0.3000</td>
</tr>
</tbody>
</table>

The EU ETS has a very specific definition of when a sector or sub-sector is deemed to be exposed to a significant risk of carbon leakage. This is the case if:

(a) The sum of direct and indirect additional costs induced by the implementation of the EU ETS would lead to a substantial increase of production costs, calculated as a proportion of the gross value added, of at least 5 percent; and

(b) The intensity of trade with third world countries, defined as the ratio between the total value of exports to third world countries plus the value of imports from third countries and the total market size for the EU (annual turnover plus total imports from third countries), is above 10 percent.
The above notwithstanding, a sector or sub-sector is also deemed to be exposed to a significant risk of carbon leakage if:

(a) The sum of direct and indirect additional costs induced by the implementation of the EU ETS would lead to a particularly high increase of production costs, calculated as a proportion of the gross value added, of at least 30 percent; or

(b) The intensity of trade with third countries, defined as the ratio between the total value of exports to third countries plus the value of imports from third countries and the total market size for the EU (annual turnover plus total imports from third countries), is above 30 percent.

\[
A_r = \frac{(Direct \ tCO_2 + Indirect \ tCO_2) \times 30 \ \€}{tCO_2} \quad \frac{GVA}{GVA}
\]

The additional relative direct and indirect costs compared to gross value added as mentioned above are calculated as shown in the formula below.

The intensity of trade for a sector as mentioned above is more specifically defined as:

\[
R = \frac{X+M}{M+Y}
\]

\( R \) represents the ratio between the total value of exports to third countries (X) plus the value of imports from third countries (M) and the total market size for the country (Y) (annual turnover plus total imports from third countries). Analytically this can be presented as the above equation, where X represents the total value of exports to third countries, M the value of imports from third countries and Y the annual turnover for the EU.

In the table below, we show as an example the summary outcome of an analysis using the above criteria. The area marked in red shows where, according to the criteria and thresholds, there is a significant risk for carbon leakage. The small blue dots represent industrial sectors in Europe. The majority of sectors exposed to leakage, shown in the red area, exceed the criterion on trade exposure.
c) Step 3: Establish the benchmarks for industrial activities.

In defining the principles for setting ex-ante benchmarks in individual sectors or sub-sectors, the starting point was the average performance of the 10 percent most efficient installations in a sector or sub-sector in the EU between 2007-2008. The aforementioned relative performance is defined as the level of CO₂ emissions in producing one production unit (e.g. one tonne of hot iron).

\[
\text{Relative Performance} = \frac{\text{CO}_2 \ (t)}{\text{unit of production} \ (t)}
\]

We will next elaborate the EU ETS benchmarking methodology in further detail.

d) Step 4: production data collection and calculation of “provisional” installation level allocation.

In the previous step, we identified the benchmark. However, because the benchmark is a relative unit (i.e. tonnes of CO₂ per unit of product), to get to the total (absolute) allocation, this benchmark will have to be multiplied by the amount of production (P) activity data based on a historical reference period. In order to ensure that this reference period is a good representation of industry performance cycles, it covers a relevant period where good quality data is available and seeks to avoid the impact of special circumstances, such as temporary closure of installations. Specifically, the historical activity levels have been based on the
median production during the period from January 1st, 2005 to December 31st, 2008, or on the median production during the period from January 1st, 2009 to December 31st, 2010. For new entrants, the determination of activity levels should be based on standard capacity utilisation based on sector-specific information or on installation-specific capacity utilisation.

The total (provisional) allocation to an installation over the period 2013-2020 is given by the formula below. Importantly, this formula includes the carbon leakage factor (CLF), which was mentioned under step 2.

\[
\text{Allocation} = \sum_{i=2013}^{2020} BM \ast P \ast CLF_i
\]

While the allocation rules and benchmarks are decided at the EU level, Member States are responsible for the implementation of the rules. In practice this means that the Member States are responsible for the collection and verification of data that are necessary to allocate allowances to individual installations. These are known as the National Implementation Measures (NIMs).

The Member States submit these provisional allocations to the European Commission, which verifies and approves them.

e) Step 5: Consistency check with total cap and final allocation and cross-sectorial correction

The final step happens once the European Commission has verified the NIMs, submitted by the Member States. It is possible that the sum of the bottom up allocation using the benchmarks and production data is higher than the total industrial sector share of allowances, which was determined under step 1. If that is the case, the EU ETS directive states that a uniform cross-sectorial correction factor (CSCF) needs to be applied. This factor balances the bottom-up allocation with the top-down cap.

The formula below gives the final allocation to each installation, now including the CSCF.

\[
\text{Allocation} = \sum_{i=2013}^{2020} BM \ast P \ast CLF_i \ast CSCF_i
\]

In September 2013 the European Commission determined, after the verification of the NIMs, the CSCF. The figure in 2013 is 94.27 percent and the figure for 2020 is 82.44 percent. The average cross-sectorial correction is therefore 88.42 percent over the period 2013 to 2020.
3.2 Principles for developing benchmarks in the EU ETS

3.2.1 Introduction

The 2008 EU ETS directive sets out certain principles for the development of benchmarks to be used for allocating allowances for free to industrial installations. In practice, these principles needed to be further refined through implementing provisions. In this chapter, we offer a short outline of these implementing provisions and how they were used to develop the product benchmarks or fall-back methodologies to be used under the EU ETS.

3.2.2 Principles guiding the development of benchmarks under the EU ETS

a) Base the benchmark (expressed as tonnes CO₂-eq/unit of product) on the average of the 10 percent most GHG-efficient installations in the EU in a sector or sub-sector covered by the EU ETS.

The fundamental principle guiding the development of the benchmarks under the EU ETS states that the benchmark should be based on the average GHG intensity, expressed as tonnes of CO₂-eq per unit of product, of the 10 percent most GHG installations in the EU over the years 2007 and 2008.

The benchmark for the installation is constructed through collecting the same performance data from all installations producing the same product in Europe and ordering them from the best to worst performer. The figure below gives a fictional example of such a curve.

Figure 5. Example benchmark curve based on installation performance data
The next step is to identify the 10 percent best performing installations. The EU benchmark for that type of installation will be the average of these 10 percent best performers. As mentioned above, the performance data used for constructing these curves is based on the years 2007-2008.

Figure 6. Setting benchmarks based on 10% best performing installations

To determine these benchmarks, the principle implies that all installations in the European Union for a sector or sub-sector covered by the EU ETS in 2007 and 2008 need to be taken into account. This also applies to installations that were outside the scope of the EU ETS before 2013 but are now part of the EU ETS.

All installations (regardless of their emissions or production volume) should be given equal weight in determining the benchmark. On the x-axis of the benchmark curve, the number of installations should thus be represented rather than cumulative production or cumulative emissions. The actual data points on the curve should be verifiable by independent verification.

The principles also state that no installations should \textit{a-priori} be excluded from the benchmark curves. The decision to exclude installations, in exceptional cases, should be made as transparent as possible

\textit{b) Do not use technology-specific benchmarks for technologies producing the same product.}

A benchmark curve has the goal of covering the full set of possible options for greenhouse gas mitigation that can be applied in a sector or sub-sector. This includes the fuel mix choice, the efficiency of heat
production and the efficiency of heat consumption in the production processes. Excluding specific technologies used in production processes from the benchmark curve would lead to sub-optimal information for both companies and policy makers and could lead, as we argued in Chapter 2, to a disadvantageous allocation for the company that has invested in these technologies or techniques.

In principle a benchmark should include the opportunities for fuel switching, efficient energy conversion and efficient energy end use.

**Image 1. Sample GHG mitigation within an installation**

![Image](image.png)

**c) Do not differentiate between existing and new plants.**

Both existing and new plants should be part of the benchmarking curve. Excluding new and more efficient installations could again lead to a disadvantageous allocation for new investments.

**d) Do not apply corrections for plant age, plant size, raw material quality and climatic circumstances.**

The concept of benchmarking is based on a comparison between different types of production installations that produce the same product. Applying corrections for plant age, plant size, raw material quality and climatic circumstances would therefore defeat the purpose of benchmarking in the first place.

**e) Only use separate benchmarks for different products if verifiable production data is available based on unambiguous and justifiable product classifications.**

It is possible that similar production plants produce different types of products. However, a separate product benchmark is only acceptable if there is verifiable production data available and if the product classification is clear and justifiable.
f) Use separate benchmarks for intermediate products if these products are traded between installations.

A production process that uses intermediate products, which are traded between installations, might lead to a benchmark and allocation that is not useable in practice. For instance, a cement-based product benchmark can lead to an over-allocation to installations that produce cement but import all clinker because most of the emissions take place in the process of producing clinker. These installations would have disproportionally higher allocations than production installations, which produce clinker for their own cement.

This problem is less relevant if allocation occurs at the company rather than installation level. This is the case in the Hubei provincial ETS.

g) Do not use fuel-specific benchmarks for individual installations or for installations in specific countries.

As mentioned under Point d, differentiating benchmarks (in this case between countries and fuels) could defeat the purpose of establishing a benchmark in the first place. In this case the application of country- or fuel-specific benchmarks would go against the principle established in the EU ETS directive to develop and use EU-wide benchmarks.

h) Take technology-specific fuel choices into account in determining benchmarks.

An exception to the principles established above would be to allow technology-specific fuel choices in determining benchmarks. One example is the use of a different benchmark for electric arc-based steel production compared to blast (oxygen) furnace steel production because the production technologies lead to different energy inputs.

3.2.3 Fall-back methodologies

In the previous part we outlined the default approach for product benchmarks under the EU ETS. However, in some cases a product benchmark is not possible to find or calculate. Therefore, different fall-back methodologies have been developed. The EU ETS implementation measures provide three fall-back methodologies as a way to establish benchmarking values.

It is possible that a product based benchmark curve cannot be developed, due to the absence of sufficient production installations. The resulting curve would contain too few data points to lead to a reliable value for the average of the 10 percent best performing installations. This is only applicable to very specific production processes; only a few exist in the European Union.

The first fall-back option is the “heat benchmark”. This benchmark (value) should be used if the heat originating from the combustion process is measurable. The emissions covered by this benchmark only relate to the production of the consumed measurable heat. Emissions covered by a product benchmark in a related production process at the same site are not covered. In some cases this will require heat flow measurements to be split towards the relevant production processes. The default value for the heat benchmark is set at 62.3 allowances/TJ of heat consumed.

If no product benchmark can be established and if the fuel is combusted but the heat from the combustion process to the process installations is not measurable, a fuel benchmark can be used. The emissions
covered by this benchmark originate from the combustion of fuels and are not covered by a product or heat benchmark. The value of the fuel benchmark is set at 56.1 allowances per TJ of fuel combusted.

Finally, if there is no product benchmark available, the heat is not measurable, the emissions do not result from the combustion of fuel, and the emissions can be classified as “process emissions”, a process emissions approach can be used. This is a grandfathering-based allocation method multiplied by 97 percent. A process installation receives 97 percent of its historical emissions for free.

We list all the fall-back methodologies in the table below.

**Table 6. Fall-back methodologies to establish benchmarking values**

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Value</th>
<th>Unit</th>
<th>Conditions</th>
<th>Relevant emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product benchmark</strong></td>
<td>depending on product</td>
<td>t CO₂/unit product</td>
<td>If a product benchmark is available</td>
<td>Emissions within the system boundaries of the product</td>
</tr>
</tbody>
</table>
| **Heat benchmark**        | 62.3                | t CO₂/TJ     | - If no product benchmark is available
- Heat is measurable       | Emissions relating to production of the consumed measurable heat, not covered by a product benchmark |
| **Fuel benchmark**        | 56.1                | t CO₂/TJ of fuel | - If no product benchmark is available
- Heat is not measurable
- Fuel is combusted        | Emissions originating from the combustion of fuels, not covered by product or heat production benchmark |
| **Process emission approach** | 97% of historical emissions (tCO₂) |                          | - If no product benchmark is available
- Heat is not measurable
- Emissions are not resulting from combustion of fuel
- Emissions are “process emissions” | All emissions with the installation not covered by the previously mentioned approaches |

**3.2.4 Dealing with cross boundary heat flows and complex installations**

When establishing the allocation for a company at a specific site, different product benchmarks are often used (e.g. the benchmark for coke production and hot-iron production at a steel company site) or that product, heat, and fuel benchmarks and the process emission approach are used at sub-installation level and combined into the total allocation. We will not elaborate these specific approaches related to complex
4. Pragmatic methodologies for the development of benchmarks under the Hubei provincial ETS

4.1 Introduction of Allocation Method in Hubei ETS Pilot

4.1.1 General Introduction to the Hubei Emissions Trading System

In order to control the growth of greenhouse gases emission, the Chinese government stated in its “12th Five Year Plan” that market instruments such as emissions trading would be applied. Soon afterwards, ETS pilot systems, including two provinces (Hubei and Guangdong) and five cities (Shanghai, Shenzhen, Beijing, Chongqing and Tianjin) were formally announced. All of these pilot trading systems will most likely start during 2013-2014, and beginning from 2015 a nationwide ETS will probably be established.

a) Introduction to Hubei province

The Hubei provincial pilot ETS is the only pilot system in the central part of China. As a developing region in China, Hubei’s GDP in 2012 is 2.225 trillion RMB, and its growth rate is 11.3 percent, 3.5 percentage points higher than the national average. Heavy and chemical industries continue to make up a large proportion of the Hubei economy, which drives CO₂ emissions up with an average growth rate of 11.65 percent. Nevertheless, carbon productivity has been increasing at an annual growth rate of 8.23 percent. The carbon intensity (carbon emissions/GDP) reduction target for Hubei during the 12th Five Year Plan period (2011-2015) is 17 percent, which is slightly lower than that of five other ETS pilot regions in China but the same as the target for Chongqing.

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Hubei’s distinct economic and industrial characteristics, compared to other Chinese regions with pilot ETS, make it a representative test case for a future nationwide ETS. Therefore, the experience in the design and implementation of the Hubei ETS Pilot could bring important lessons and implications for the future national Chinese ETS design.

b) Coverage of the Hubei ETS

Coverage of Hubei ETS relates to two points. First, there is the “macro” level, which refers to the emissions and sector that will be covered by the Hubei ETS regulation. Second, there is the “micro” level, which refers to the firm’s emission boundary.

**Hubei ETS covered emissions:**

Although GHGs commonly include six types of gases, the Hubei ETS will start by only covering CO₂ emissions during its pilot phase. This is consistent with the first phase of the EU ETS, RGGI and the Tokyo Metropolitan ETS. Limiting the scope to CO₂ emissions will make the data collection in the early stages of the Hubei ETS easier.

**Hubei ETS Sectorial coverage:**
The sectorial ETS coverage is determined by a sole criterion: whether an enterprise’s energy consumption exceeds a predetermined threshold. During the pilot phase, all industrial enterprises whose energy consumption equal or exceed 60,000 TCE (tonnes of coal equivalent) in 2010 or 2011 fall under the scope of the Hubei ETS. Over 150 energy intensive companies are expected to participate in the Hubei ETS. These contributed to more than 35 percent of the provincial total emissions and nearly 48 percent of the provincial industrial emissions in 2011. Although no sectoral-specific criteria have been set, the covered enterprises are distributed among the largest greenhouse gas emitting sectors in Hubei.

Figure 9. Hubei ETS covered sectors by Proportion of Emissions Output

The company level emission boundary:

Because the Hubei ETS is designed to be implemented over a rapid timescale, the province has opted to use the traditional company-based classification system. The company’s emissions may combine with other installations and subsidies that fall under different sectors or subsectors. Due to the traditional company level classification system used in Hubei and the urgent timetable for preparing, Hubei ETS, similar to other pilots in China, is hard to divide the emission unit into the installation level. ETS at the company level may bring convenience in collecting data at the early stage, but it might also cause complexity in determining the company’s emission boundary due to their complicated organizational structures. The Hubei ETS Pilot uses a company’s organization code as the identification to define the boundary of the company. In this system, a large company may have several subsidiaries with their own organization code.

By setting the emission boundary at the company level instead of the installation level (as is the case in the EU ETS) the monitoring, reporting and verification (MRV) will also occur at the company level. Since the existing energy consumption monitoring data are currently at the company level in China, it is difficult to collect installation level data given the very limited preparation time for the implementation of the Hubei ETS. This company-level emission boundary also limits certain allocation methods. For instance, an EU ETS type of benchmarking method will be hard to apply at the beginning due to the limited availability of accurate installation-level benchmarking data.

4.1.2 Allowances Cap and Reserve

a) Allowances Cap
Hubei has built an input-output model to forecast its CO₂ emissions during the 2013 - 2015 period under different scenarios, taking into account factors such as economic development, industrial structure, emissions reduction, and urbanization, among others. Since Hubei is still developing at a very fast pace, Hubei’s CO₂ emissions will increase in future years. Nevertheless, the Central Government requires Hubei to decrease its carbon intensity (CO₂ emissions per GDP) by 17 percent during the “12th Five Year Period” (2011-2015). Hubei’s forecast model takes this target into account.

A specific feature of the Hubei ETS is the introduction of a double allocation method, which includes a direct emissions allocation to companies where the emissions take place and an indirect emissions allocation for the electricity consumers. As such, emissions related to power production are allocated twice. This approach is taken because, in China, the electricity price is still in control by the government, and therefore the carbon price cannot be passed onto the downstream industries that consume power. The double allocation method could in theory help limit the emissions of industries that heavily consume electricity by enhancing their motivation to reduce power consumption; lowering electricity consumption will allow these firms to sell more allowances.

Figure 10. Direct and indirect emissions of CO₂ in Hubei (2013-2015)

b) The structure of the allowance cap for the Hubei ETS

The Hubei ETS cap is set following the ratio between the emissions by covered companies and the overall emissions of Hubei Province. The covered company’s energy-related emissions (includes direct and indirect) take up around 35 percent of Hubei’s total CO₂ emissions.

The allowance cap is divided into three parts:

- Allowances for the existing installations (“incumbent allowances”).
- A reserve for new installations (“new capacity reserve”).
- A reserve for the government (“government reserve”).

Allowances to incumbents:

The number of allowances for incumbents will equal 97 percent of the total emissions of covered companies in 2010, and is unchanged during the 2013-2015 period.
The Government Reserve:

The government reserves a fixed proportion equal to 8 percent of the total allowance cap for the purpose of market supervision and intervention.

The government reserve will be used as follows:

- When the allowance prices fluctuate too much, the government can use the reserve to intervene in the market through open market operation.
- The revenues from open market operation can be used to cover the management expenditure of the Hubei ETS and for the low-carbon technology research fund.
- A very small proportion of it could be used towards the auction in order to facilitate the carbon price discovery by the market at the initial stage.

The New Capacity Reserve:

The remaining allowances after allocations are made to incumbents and the government are placed in the new capacity reserve. Since Hubei’s emission will increase in the near future, the new capacity reserve is also increasing over time. If the new capacity reserve is not used up, the remained part will transfer to the government reserve automatically.

**Figure 11. Allowances of Hubei ETS showing growth of new capacity reserve**

<table>
<thead>
<tr>
<th>Cap and Reserve for Hubei ETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
</tr>
<tr>
<td>Government</td>
</tr>
</tbody>
</table>

c) Allowance Adjustment Mechanism in case of significant supply/demand imbalance

At the beginning of the pilot phase, it is difficult to judge whether the initial allocation will lead to an allowance scarcity or surplus before the first compliance round. This is largely due to the uncertainty related to projected economic growth. In the past years, China’s economy has experienced the negative impact of the global economic crisis in 2009 and the slow recovery in the years 2010-2012. In future years, the growth rate is expected to be lower than the previous past ten years due to structural adjustment in China. Steel, cement, chemicals and other sectors, which have had excessive capacity in the past years may experience slower growth in coming years, but the true impact of this adjustment is uncertain.

Under such uncertain circumstances, it is crucial to introduce an adjustment mechanism in case of excessive allowance surplus or shortage conditions in the market:
• In case of excessive allowance surplus the next year’s allocation, the government can deduct allowances from the market equal to the number of remaining allowances in the registry after compliance and cancellation for the previous year’s emissions.
• If the government determines that there will be a significant shortage of allowances in the market and the allowances price is rising quickly (or if most companies are buying and not selling), it can put part of the government reserve into the market.

4.1.3 The allowance allocation methodology in the Hubei ETS

Hubei province has designed an allocation method that serves its unique needs after conducting research, including research comparing allocation methods applied by main emissions trading systems in the world.

a) The Gradual Hybrid Allocation method

Currently, the main allocation methods for an ETS include free allocation, auctioning and/or a combination of both (also known as a “hybrid method”). The free allocation method allows large emitters to obtain emissions allowances free of charge, which could lead to lower economic efficiency. Full auctioning has always been regarded as the method resulting in the highest emissions reduction efficiency, but this method increases firms’ costs and decreases their competitiveness. Therefore, auctioning often faces strong resistance from companies.

Since Hubei is still in a developing stage with high economic growth, it makes sense to apply the “Gradual Hybrid Allocation Method”. Using this method, the majority of allowances will be allocated for free in the pilot phase. After the pilot phase, allowances will be allocated both for free and through auctioning. The ratio of auctioning versus free allocation will increase until it transitions to a full auctioning method.

b) Mainly Free Allocation during the Pilot Phase

There are several advantages for Hubei in applying a primarily free allocation method during the pilot phase. First, it could increase the positive and pro-active involvement of covered companies during the pilot phase. Secondly, free allocation in the pilot phase would help to minimize possible conflicts during the pilot phase, when institutional and administrative rules for Hubei ETS are still imperfect, providing a harmonious market and social environment while perfecting the policy, institution and mechanism. Third, in the pilot phase, the neighbouring provinces of Hubei will not build and run the ETS. If Hubei province auctions the allowances (and hence make all installations pay for their emissions), it will harm the competitiveness of the covered companies relative to competitors in neighbouring provinces, which are not covered by an ETS. Thus, the ETS pilot phase in Hubei province will see no more than 3 percent of its allowances auctioned.

4.1.4 Allowance Allocation at company level

Hubei will allocate the majority of allowances for free to covered companies during the pilot phase. Below we outline the allocation methods for incumbents and for new entrants.

a) Allocation Method for Incumbent companies
An incumbent is defined as a company that is mentioned on the official “Company Inventory List for the Hubei ETS Pilot”. Each company with total energy consumption above 60,000 tons of coal-equivalent in either 2010 or 2011 is marked with an organizational code.

**Allocation Method for industrial companies (not power plants)**

The allocation method for industrial companies other the power sector is grandfathering based on their historical emissions. The company level allocation is calculated using the following steps:

**Step 1:** Set an industrial sector cap for each industrial sector covered by the Hubei ETS according to the proportion of the industrial sector’s emissions out of the total emissions of all covered companies.

**Step 2:** Determine the initial allowance allocation for each company, which is equal to the company’s average historical emissions during the years 2009-2011.

**Step 3:** Calculate the cap correction factor, which equals to the total allowances of the industry (as determined under Step 1) divided by the sum of initial allowances (as determined under Step 2) of all covered firms in one industry.

**Step 4:** Determine the final allowances for each company, which is the product of its initial allowances and the cap adjustment factor.

**Allocation Method for power plants**

Allocation for power plants combines grandfathering and benchmarking methods. The electricity price in China is not determined completely by the market. Meanwhile, power plants are responsible for ensuring sufficient supply of electricity. As a result, the amount of electricity generated by power plants is not solely determined by their operating condition. Thus, it is not suitable to use auctioning to allocate for power plants. Hubei has designed the following allocation method for power plants:

**Step 1:** Allocate to every power plant the amount of allowances equal to 80 percent of its historical emissions.

**Step 2:** If the plant generates an amount of electricity that surpasses 80 percent of the amount in the base year, the additional allowance will be allocated using benchmarks. The benchmark is set at the CO2-intensity (CO2/kWh produced) of best 30 percent companies of all covered power plants.

**b) Allocation Method for new entrants/new capacity**

New capacity is defined as a new project/installation that expands the capacity of an existing company. If the new capacity leads to a 15 percent increase in the company’s original carbon emissions or exceeds 100,000 tons of carbon emissions, the company can apply for additional allowances. The allocation for the new capacity is also freely distributed. The allowances are derived from the new capacity reserve.

The detailed steps are as follows:

**Step 1:** Determine the start-of-production (SOP) date. Hubei uses the SOP date in the project/installation approval files in order to avoid unreliable emission data during the test run of the new installations.
Step 2: Calculate the allowances in the year of SOP date. The new capacity will receive the allowances in the first year in which it operates equal to the amount of its emissions between the SOP date and December 31\textsuperscript{st} of the same year. The allowances will be added to the company's account after the verification of the emissions.

Step 3: Set the amount of allowances in the following year. The amount of allowances allocated to the new capacity in the year following the SOP equals the daily average emissions between the SOP date and December 31\textsuperscript{th} in that year, multiplied by the number of days in a whole year.

c) Closure Rules

Closure rules are set both for a company closure and an installation closure in an incumbent company:

If a company closes in the middle of a year, it should submit a number of allowances, equal to its emissions in the closure year. The remaining allowances will be retained and cancelled by the government.

If an installation of an existing company is shut down, the following year’s allocation to the company will be reduced by an amount equal to the historical emissions of the closed installation. If the installation’s emissions cannot be distinguished from the company level data, the number will be calculated from the designed capacity and energy consumption of the installation.

4.1.4 Planned adjustments to the allocation methods after the ETS pilot phase

Hubei province has designed the above allocation method according to its own specific conditions and needs. After the pilot phase, the allocation method of the Hubei ETS may be adjusted according to the design of a future nation-wide ETS in China. Notwithstanding the future national ETS, Hubei province plans to change its allocation method by gradually increasing the auctioning proportion and moving from a grandfathering method to a benchmarking method for the remaining free allowances.

a) Increase the proportion of auctioned allowances gradually.

China may begin a nationwide ETS after 2015. This implies that Hubei province may need to adjust its allocation method after the pilot phase according to the national ETS design. Notwithstanding potential national developments, Hubei province has designed a roadmap to transfer from free allocation to an auctioning method after the pilot phase. According to the roadmap, the proportion of free allowances allocated should decrease gradually, while the proportion of auctioned allowances should increase correspondingly. The proportion of allowances auction for the Hubei ETS is presented in different stages in the following table.

Table 7. Allowances allowed through auctioning post-2015 based on Hubei roadmap

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No more than 3% auctioning</td>
<td>10% auctioning</td>
<td>30% auctioning</td>
<td>50% auctioning</td>
<td>80% auctioning</td>
<td>100% Auctioning</td>
</tr>
</tbody>
</table>
After the pilot phase, a portion of allowances will still be available for free allocation. For the free allocation method, Hubei is planning to move from a grandfathering method to a benchmarking method. However, the benchmarking method demands a large amount of emission and activity-level data. This will require a stricter and more detailed MRV system, including higher-level data quality and accuracy at the installation level. Hubei province intends to start applying the benchmarking methodology to industries with comparatively uniform products, such as electricity and cement. The method could next be applied to industrial sectors with more complex product classifications.

In the next section, we will outline how a benchmarking methodology can be developed for the Hubei ETS in the short- and longer-term. This paper will then apply these concepts to the power sector and the cement sector.

4.2 Possible methodologies for the development of benchmarks in the Hubei province

4.2.1 Application of the EU ETS benchmarking approach

Applying the EU ETS benchmarking approach to the Hubei ETS should be possible in principle. However, the development and implementation of these benchmarks in the EU was a lengthy process, taking more than three years. Furthermore, the process was facilitated by the availability of at least three years of verified emissions data at the installation level. As mentioned previously, the EU ETS benchmarks use two years of historical production and emissions data. Even with this thorough preparation and the availability of production and emissions data in the EU, product-based benchmarks were not feasible in all cases. This necessitated the use of fall-back methodologies as explained in the previous chapter.

Next, we will outline a blueprint for how the Hubei ETS can develop benchmarks using a methodology similar to the one used in the EU ETS. As mentioned above, there will be data and time constraints limiting the comprehensive application of this methodology within the next two years. However, in preparation for the use of such methodology in the next phase of the Hubei ETS or its integration into a national Chinese ETS, we propose a list of other ways to use benchmarks or a benchmark-type approach in the Hubei province in the near-term, or as a permanent alternative and more pragmatic policy choice.

To develop an EU ETS type benchmarking system in the Hubei province the following steps need to be considered:

a) Definition of the appropriate benchmark
b) Data acquisition and data quality
c) Appropriate use of fall back methodologies
d) Rules on how to deal with complex industrial installations

a) Definition of the appropriate benchmark(s)

The first methodological choice to be made is the actual definition of the product benchmark. In the EU ETS, as we mentioned before, the benchmark is defined as being the average GHG efficiency of the 10 percent best performing production installations. There are alternative approaches such as setting the
benchmark at the level of the 10 percent best performing installation (the “decile”). This was the common approach in the Dutch and Flemish benchmarking energy convenants.

In principle, it is important from a policy perspective to identify the “sweet spot” on the curves. Most benchmarking curves have a horizontal s-shape with an almost flat area in the middle. Ideally, the benchmark is set just beyond the point where the curve turns downwards, since this is where significantly more energy-efficient installations reside. Setting the benchmark at the beginning of this curve could lead to a value that is too ambitious, as it requires very expensive investments or technologies to meet for an installation with an average GHG efficiency.

**Figure 12. Identifying benchmark using benchmarking S-curve**

![Benchmarking S-curve](image)

The place on the benchmarking S-curve, which is most relevant for policy makers since it indicates realistic improvements in CO2-intensity better than the average intensity.

It is possible that a benchmark curve, once data is collected, demonstrates an almost flat curve, with the most efficient installations not being significantly more efficient than the average. This could imply a very homogenous region when it comes to fuels used; techniques and technologies employed, and plant age. If so, the benefit of using a benchmark to allocate allowances is small and a grandfathered-based approach that includes an overall correction factor might be more appropriate. This can also be avoided through widening the region in which data is collected for the development of the benchmarking curve. If a flat benchmark curve for a certain type of product appeared in the Hubei province, one could consider widening the scope of the region included in the benchmarking curve to other provinces, or even the whole of China.

To further define the benchmark, decisions must be taken about the types of installations to include in the curve. We refer here to the principles used under the EU ETS as mentioned in the previous chapter, which
include no discrimination between different technologies, new and existing installations, plant age, raw material inputs, etc.

We could argue that implementing the principle used in the EU ETS benchmarking system in favour of product benchmarks for intermediate products traded between installations (such as clinker for cement production) should not necessarily be applied to the Hubei ETS, as the allocation level in the province is at the company level rather than installation level, thus limiting the issue of traded intermediate products.

It is possible that for some product benchmarks, production installations data in the Hubei province is insufficient to establish a reliable benchmarking curve. In those cases, fall-back methodologies should be considered. We will highlight these in the next part. Increasing the regional scope for establishing the benchmarking curve may also be appropriate. This could mean consideration installations from regions in China with a similar economic and industrial profile as the Hubei province or using data for the whole of China. While this would require more time to develop, these benchmarking curves could have use beyond the Hubei province, potentially as part of the design of a national Chinese ETS, through their broader scope.

b) Data acquisition

Once the type of benchmark has been defined, the process for data collection can begin, with the goal of establishing the actual product benchmark curves and identifying the benchmark values to be used for allocation.

The first step is to generate a comprehensive list of products covered by the separate product benchmarks. The next step is the construction of a complete list of all production installations (not companies) that will be covered by the ETS. Finally, each installation will have to be linked to a specific product or production process as mentioned in the first step. It is of course possible that installations produce more than one product and are therefore linked to more products on the list.

Once all installations are identified, a technical description of each installation must be developed. This is very similar to the monitoring plans that are developed for the reporting and verification of emissions, but at the installation level. The technical description, including types of fuel used and the methods of measurement, should allow for the identification of heat/energy flows between different installations producing different products or heat/energy flows between installations both covered and exempted by the ETS.

For each installation the main data to be collected are GHG emissions and production volumes related to these emissions per installation. Preferably, these data are collected following the rules established in the monitoring plan. The data must be independently verified and approved for use in the benchmarking curve.

It is possible to use historical installation level data that did not follow the rules in a monitoring plan (e.g. since data were collected before there was a monitoring plan); however, this should only be in exceptional circumstances, and data collection should continue to follow a consistent and transparent methodology across all production installations. Furthermore, the data have to be replaced with more accurate information following the rules of the monitoring plan as soon as it becomes available.

c) The use of fall back methodologies
In the previous chapter we outlined the fall-back methodologies for the EU ETS benchmarks. The heat and fuel benchmarks of 62.3 t CO₂/TJ and 56.1 t CO₂/TJ, respectively, are based on the use of natural gas with a fuel to heat conversion factor of 90 percent.

For the Hubei province, different fall-back values could be considered. It is also possible to use default fall-back values that are corrected or adjusted to reflect the energy and carbon intensity objectives of the province as part of the current 5-Year Plan.

d) Complex industrial installations

Finally, it is important that benchmarking and fall-back approaches are simulated for complex industrial installations that produce multiple different products or are linked to other industrial production installations. In particular, different production installations that have a trans-boundary heat flow must be carefully addressed. These simulations should inform policy makers and lead to consistent benchmarking approaches across industrial sectors. For a detailed description of possible options, we refer to the report “Methodology for the free allocation of emission allowances in the EU ETS post 2012.”

4.2.2 Possible alternative benchmarking approaches

In the previous part, we outlined how an EU ETS-like benchmark approach could, in theory, be applied in the Hubei province. However, the EU ETS benchmarking approach is not the only option for implementing benchmark-based allocation. Some alternative approaches we will outline in this part of the paper could be implemented over a shorter time horizon in the Hubei province, particularly because they require less up-front installation level data collection.

a) The Region Method

If timely data acquisition in the Hubei province proves to be difficult for the development of benchmarking curves, an alternative method could be the “Region Method,” which is used as a fall-back approach in the Dutch and Flemish energy benchmarking convenants.

In this method, one looks at a list of regions, which are comparable to the Hubei province in the number and size of process installations. The average GHG intensity for comparable processes and process installations will be determined for these regions. The benchmark value will be the GHG intensity of the region with the best performing average GHG intensity for a specific process.

The advantage of this method is twofold. First, it does not require the collection and verification of historical emission and production data within the Hubei province. Second, it makes it possible to look at existing studies and reports on the GHG intensity of different production installations across different regions and use this literature analysis to define a benchmark.

b) The Best Practice method

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Another fall-back methodology used in the Dutch and Flemish convenants is the “Best Practice” or best available technology approach. Using this method, one looks for the most GHG-efficient process installation at a global scale, and sets the benchmark at an efficiency level 10 percent lower than best practice. The benchmark development or research is technology-driven, as it is developed in comparison to the most optimal production installation. Again, this approach requires much less upfront data collection and can be done through literature reviews and the use of readily available technological best practice studies. In practice, policy makers have the option to change the scope from a global scale to regional best practices, or determine the margin from the best practice to be more or less than 10 percent.

c) Independent Auditing method

An alternative, more time-intensive method to set technology-driven allocations is independent auditing, in which an independent expert audits each process installation. The expert identifies all possible measures that can be taken to reduce the GHG intensity in the installation and lists these together with the associated investments costs and internal rates of return or payback times. Policy makers can next decide allocation levels based on GHG intensity, following the implementation of all measures with an internal rate of return of x percent. A common applicable rate of return for cost-effective measures could be 15 percent, implying a payback time of 3-5 years with initial investments written off over a period of 10 years.

Policy makers can decide to apply these GHG efficiency improvements at each plant individually or take the average of the GHG intensity improvement for cost effective measures following the audits. The latter can be achieved using data from all installations in the province or by using a representative sample.

d) Applying autonomous development to a benchmarking value

A final element to consider, both for an EU ETS-type benchmarking approach or any of the alternative methods, is the use of an autonomous development factor. This factor would be added to the allocation formula to represent the extrapolation of historical improvements in GHG intensity into the future.

The best way to determine such factor would be to look at historical data for each type of production process installation. However, these data in most cases are not readily available. Therefore, a more generic factor could involve the recent evolution of CO₂ intensity at provincial or national level.

4.2.3 From benchmarking to allocation

Some of the allocation principles as they are formulated in this section are generally applicable to all sectors for which a benchmark-based allocation methodology could be developed.

In general, any allocation based on benchmarking can be calculated as:

Allocation (1) = Activity Level (2) * Benchmark (3)

With:

Allocation (1) = Allocation of allowances given out for free in t CO₂ / year

Activity level (2) = Activity level the benchmark refers to (e.g. t product / year)

Benchmark (3) = Benchmark for the activity indicator (e.g. t CO₂ / t product)
In the case of EU ETS-type benchmarks, the data used to establish these will be derived from all installations and occurs at the installation level. Therefore, the activity data used for the allocation is production at the level of the installation. In the Hubei province, allocation occurs at the company level, covering all the installations owned by one specific company.

As mentioned above, the development of EU ETS-type benchmarks in the Hubei province requires the collection of data at the installation level. However, once benchmarks are developed, allocations can still be made at the company level. In this case, the benchmark is multiplied by the relevant activity data at company level. The image below shows how this could work.

**Image 2. Company allocation based on product benchmark and relevant company-level activity**

5. Testing benchmarks to allocate allowances in the cement sector and power sector in Hubei province

5.1 Cement sector

5.1.1 Introduction

In this section, we will examine how a benchmark for cement production can be developed for the Hubei province. We will start with the application of a methodology based on the current EU ETS methodology,
including the methods for data collection. We will also present the possible application of alternative approaches that can be implemented within a shorter timeframe.

5.1.2 Applying a benchmarking methodology similar to the EU ETS

a) Introduction

The primary choice regarding benchmarking for the cement sector is deciding whether to use a cement- or clinker-based benchmark. The European Commission has compiled arguments in favour of either cement or clinker benchmarking, with the end result in favour of clinker benchmarks\(^4\). One primary argument advocating for the use of clinker benchmarks is that many companies trade or transfer clinker between their individual plants, so applying cement benchmark could not be work accurately because the emissions would not be assigned to the origin of the emissions (i.e. the clinker production).

On the other hand, clinker benchmarking does not incorporate clinker substitution in the benchmarking methodology. This means that clinker benchmarking could provide a negative incentive for blending, as increased blending could result in fewer allowances allocated in the next trading period. A clinker benchmark could also distort incentives to invest in blended cement. We conclude that a clinker benchmark has the risk to both punish early actions in companies with a high non-clinker blending rate and to distort investments in favour of cement with high clinker content.

b) Data Collection

Hubei province will need to organize a data collection effort relating to each ETS incumbent installation. It will need to develop specific data collection obligations that should follow the allocation rules in a harmonized way.

As we mentioned above in Part 4.2.1, a methodical approach is needed to acquire relevant installation level data, as to establish a cement benchmark.

1. The first step is to generate an unambiguous list of the products that will be covered by the established cement benchmark.
2. The next step is the construction of a complete list of all production installations (not companies) in the Hubei cement sector that will be covered by the ETS.
3. Each identified installation will have to be linked to a specific product or production process as mentioned in the first step. It is possible that installations produce more than one product and are therefore link to more products on the list.
4. Once all installations are identified, a technical description of each installation has to be developed. This is very similar to the monitoring plans that are developed for the reporting and verification of emissions, but are developed at the installation level for each of the cement plants. The technical description should include types of fuel used and should allow for the identification of heat/energy

flows between different installations producing different products or heat/energy flows between
installations covered by the ETS, as well as those that aren’t.

5. The main data to be collected for each cement-producing installation are the GHG emissions and
the production volumes related to these emissions from the same installation. Preferably this data
is collected following the rules established in the monitoring plan. The data has to be
independently verified and approved for use in the benchmarking curve. It is possible to use
historical installation level data that did not follow the rules in a monitoring plan (e.g. since data
were collected before there was a monitoring plan); however, this should only apply in exceptional
circumstances and continue to follow a consistent and transparent methodology applied across all
production installations. Furthermore, the data have to be replaced with more accurate
information following the rules of the monitoring plan as soon as it becomes available.

During the above mentioned data collection process, operators of the installations will need to provide the
following reports, using templates made available by the competent authority:

1. A baseline methodology report presenting how specific data were determined.
2. A baseline data report, including the emissions and activity data relating to their installation.
3. A verification report, proving that the data has been verified and validated by a third-party.

To assist with the implementation of the data collection, the installation operators will need detailed
guidance on what the data is and how it should be collected.

In Annex I, we outline the data needed for establishing the cement benchmark, and what choices will need
to be made when using the data and building the benchmark. The activity data collection can have a dual
use. It will not only help to determine the benchmark but also will provide historical activity data that can
be applied to determine the final allocation.

c) Building the Benchmarks

Following the construction of benchmark curves, as outlined in Chapter 4, the Hubei province will need to
determine at what percentile to set the benchmarks. That question must be answered by the policy makers
in Hubei, based on the ultimate goals of the ETS, e.g. what levels of emission reduction is desired by the
competent authority.

In any case, focusing on GHG intensity is a straightforward approach to measuring the production
processes of products where no heat carriers such as steam or carbon containing waste product cross the
system boundary. This is true of the cement sector. In such a case, the benchmark curve can directly
contain the GHG intensity per unit of production, consisting of direct fuel related emissions and, if
applicable, process emissions.

5.1.3 Alternative methodologies to establish cement benchmarks

The development of benchmarks on short notice (e.g. within a few months’ time) using the methodology of
the EU ETS will be very difficult practically in Hubei province. Over time however, with the availability of
emissions data following the implementation of the monitoring plans, more comprehensive and detailed
data will become available to establish high quality benchmarks.
However, at a global level, the cement sector has made big efforts in data collection that have led to global, regional and company-level GHG intensity data. In particular, the Cement Sustainability Initiative (CSI) lead by the World Business Council on Sustainable Development (WBCSD) has developed the “Getting the Numbers Right (GNR)” database. According to the WBCSD, "Getting the Numbers Right" is a voluntary, independently-managed database of CO₂ and energy performance information on the global cement industry. The database delivers uniform, accurate and verified data so that the industry can understand its own current and future performance potential. Key drivers of emissions and performance are also included. The database also provides policy makers with current performance data to aid their analyses and decisions. The GNR database now covers data up to 2011 (competition law concerns recommend a one-year time lag in publishing data). It has grown over the years to cover 967 individual facilities producing 880 million tonnes of cement. This represents 25 percent of global cement production. 94 percent of the data is assured at the participating company level by independent third parties.

The significant volume of data available in the GNR should offer the Hubei province sufficient information to develop a benchmark on very short notice, following the “region” or “best practice” methodologies which we outlined in Chapter 4.

As an example, we show the CO₂ emissions per tonne of cement in 2011 by GHG intensity globally (according to the data available to the GNR database). The most efficient production stands at around 400 kg CO₂/t cement and the weighted average is 629 kg CO₂/t cement. This is shown in the figure below.

![Figure 13. Net CO₂ emissions per tonne of cement by GHG intensity (2011)](image)

However, we consider it still to be useful for the cement companies in the Hubei province to gather installation level data and to assist the provincial government in developing an average GHG intensity value for cement production in Hubei. This would allow comparison of the current GHG intensity with a benchmark derived using the region or best practice method.
5.2 Power sector

5.2.1 Introduction

In the EU ETS, installations producing only electricity are not eligible for free allocation, with the exception of installations in Eastern Europe (admitted to the EU in 2004), who are allowed to allocate some free allowances during the 2013-20 period (max 70 percent in 2013, down to zero percent in 2020) to power producers. In the first two phases of the EU ETS (2005-2007 and 2008-2012) before auctioning became the default methodology for the power sector, some EU Member States used benchmarks to allocate allowances (for free) to installations in the power sector.

Benchmarks for electricity production are more straightforward as electricity is a more homogenous product. However, the implementation of these benchmarks must be carefully considered, particularly in the context of regulated power prices. This is the case for Hubei province.

In this part, we will not focus on the possible use of benchmarks in the Hubei ETS. The actual establishment of benchmarks follows a similar procedure as the one we established in Part 5.1 for the cement sector. In Annex II of this paper, we provide a specific methodology for data collection in the power sector that allows the development of benchmarks, including for CHP installations.

5.2.2 How to use benchmarks for the power sector in Hubei province

Because power prices are regulated in China, power producers have limited opportunity to pass through the cost of reducing CO₂ to the power consumers. This limits the mitigation options and actions that the power sector can undertake.

Structural deregulation of power prices and/or the legal option for power producers to pass through the carbon price within the electricity price would be the most logical option to enhance the effectiveness of the ETS in the Chinese pilot systems. However, this is a decision that needs to be taken at the national level. It is certainly an issue to consider as part of the development of a future national Chinese ETS.

In this regard, the choice by Hubei province to allocate the indirect emissions to the electricity consumers as well is appropriate, as it offers consumers the option to reduce power consumption and thus reduce the exposure to carbon costs.

The main benefit of benchmarks for the power sector in Hubei is the resulting detailed information on the carbon intensity of the power sector in the province. This will allow governments to create better policy analysis leading to improved knowledge on how the Hubei power sector will contribute to the carbon intensity targets set in the 12th 5-Year Plan for the province and the forthcoming 13th 5-Year Plan.

Furthermore, the overall carbon intensity of the power sector also depends on the share of power producers, which include some not covered by the ETS, such as nuclear power plants and renewable energy producers. Policies and measures that increase the share of renewable energy can contribute significantly to lower carbon intensity for the power sector.
The ETS, on the other hand, will encourage lower power consumption through indirect emission allocation. It will also, depending on the tariff structure, push power producers towards the use of plants with higher thermal efficiency and potentially create a shift towards lower coal use in favour of natural gas.

The benchmarks for the power sector can be used to reward power producers operating more efficient power plants. At this stage, setting a fuel-independent benchmark appears unlikely due to the extremely high share of coal use in the power sector. Setting a benchmark at the level of natural gas-fired power plants would lead to unrealistically low benchmarking values for the province in the short term. A fuel specific benchmark could be used in the future. However, a benchmark-based allocation that rewards the use of combined heat and power can be recommended. We outline such methodology in Annex II.

Finally, the free allocation for new capacity and new installation should use the most stringent benchmarks to encourage power producers to only invest in best available technologies. The information on such benchmarks for new installations should be publicly available in international technical literature.

Ideally, the allocation to the power sector should occur through auctioning. However, as we explained above, the regulated power prices in China are not compatible with such an approach. It can be conceived as part of future research to simulate a situation in which new regulations allow power producers to pass on the carbon cost in the power price. Such a simulation might look at the economic impact of full auctioning for the power sector on domestic and industrial consumers, taking into consideration the specific economic structure and development of Hubei province. These simulations could include different options in which the auctioning revenues from the ETS are used to compensate power consumers for the higher costs they may face.

5.3 Conclusions

We conclude this chapter by stating that, in principle, an EU ETS benchmarking approach should be possible in the Hubei ETS in the future. However, this is conditional on specific verified data acquisition at installation level for at least two years. On the short term, alternative approaches leading to benchmarks can be used for allocating allowances. Particular examples are the WBCSD Global Cement Database and existing literature on power plant carbon efficiency.

The debate on benchmarking in the power sector must be looked at in the broader context of the power sector structure and the regulated power prices in China. Regulated power prices limit the options for cost-effective mitigation under an ETS. However, in regards to allocations to new power plant capacity, an ambitious benchmark can push power producers to choose state-of-the-art technology for new capacity.
6. The Hubei pilot ETS in relation to a future Chinese National ETS

6.1 The Significance of the Hubei ETS to a forthcoming Chinese National ETS

Hubei is the only province in central and western China to be selected by China’s National Development and Reform Committee (NDRC) as one of seven ETS Pilots. The experience with ETS development can be representative for establishing a future ETS in China, as the fundamental conditions in Hubei, such as the technical capacity, economic development stage, industrial structure, social awareness and multi-level administration can be considered similar to conditions at a nationwide scale under a national ETS. In this regard, Hubei’s experience with the Pilot ETS implementation could be valuable for the national government in addition to the specific experience gained in most of the other pilot ETS systems in the more developed and/or large municipal parts of China.

6.1.1 The Representativeness of Hubei ETS Pilot

Hubei is an important province in the central part of China. Within China, it is considered a “developing province” based on its economic weight, growth rate and industrial structure. Hubei’s economic weight falls within the upper middle among the 31 provinces in China. Hubei’s economy is also growing rapidly. Its GDP growth rate is higher than the national average. Hubei’s development is still heavily reliant on secondary industry. In particular, energy intensive sectors still make up a large proportion of the Hubei economy. This includes steel, chemicals, cement, car manufacturing, power and non-ferrous metals. In this regard, Hubei’s economic structure is very similar to China’s overall economic characteristics due to its strong economic growth momentum and industrial structure.

Hubei’s industrial structure and economic development contribute significantly to its carbon emissions volume and emissions trend. First of all, the secondary industry makes up the largest share of the province’s carbon emissions. According to calculations by Wuhan University, in the “11th Five-Year Period”, emissions from secondary industries contributed over 60 percent of the yearly provincial emissions. Among these industrial sectors, the power, chemicals, cement, steel, car manufacturing, and non-ferrous metals sectors are the five biggest emitters. These sectors are also high-energy consumers in China. Second, in the near future, Hubei’s carbon emissions will continue to grow. This is consistent with the overall trend in China. Third, during the “12th Five-Year Period”, Hubei’s carbon intensity and energy intensity are required to decrease by 17 percent and 16 percent, respectively. This target is the same as the national average, but is lower than those developed for other ETS Pilots (except for Chongqing).

The aforementioned economic relationship between Hubei province and China as a whole indicates that the development of industrial benchmarks in Hubei province can be very relevant for the development of a Chinese National ETS. The sectors covered by Hubei ETS are also the sectors in China with the highest emissions. It is expected that that these sectors would also be covered by the National Chinese ETS. Researching benchmarks in Hubei province and comparing the resulting values with other provinces or values available from scientific literature for China can additionally help determine whether the technology level in industrial sectors in Hubei is representative of China as a whole. If so, the National ETS could reference the benchmark values developed under the Hubei ETS.

a) Sectors Covered by Hubei ETS are also the High Emissions Sectors in China
The sectors covered by the Hubei ETS include cement and glass, chemicals, power and heat, steel and non-ferrous metals, food, petroleum, automobile manufacturing, and other sectors including as medicine, chemical fibres, paper and pulp. These sectors are also consumer large amounts of energy and emit high levels of carbon, and are regulated strictly by the China government. The top three sectors with the highest number of companies participating under the Hubei ETS are cement, chemical and power. These sectors have more than 27 companies covered by the ETS for each sector. This is high compared to the other ETS pilots in China. Among these sectors, cement and power are relatively simple products, with the number of participating companies around 30 for both sectors. Therefore, developing benchmarking methodologies in the cement and power sector in Hubei ETS could be very relevant for the forthcoming nationwide ETS in China.

Figure 14. Number of enterprises covered by Hubei ETS and proportion of emissions covered

b) Hubei’s industrial technology level can contribute to a benchmarking reference for the National Chinese ETS

Since Hubei is still in an economic development stage, its technology level can also be representative of other ETS Pilots in more economically advanced parts of China. The power sector could be taken as an example. The power plants covered by Hubei ETS are mainly coal-fired power plants and combined heat and power plants (CHP). Other ETS pilots differ in primary fuel source. Shenzhen, for instance, only has eight power plants, only one of which is coal-fired; the other seven all use natural gas as a fuel. The carbon intensity of the coal-fired power plants in Hubei, on average, is 0.898 tCO₂/MWh. Although it is still higher than the international advanced level, it is lower than the national average in China. Therefore, the development of a power sector benchmark value in Hubei province will contain useful information for the forthcoming national ETS in China.
6.2 Development of benchmarks in Hubei and the relation to a forthcoming national Chinese ETS design

We conclude this chapter by assessing the practical relevance of further development of allocation methodologies, such as benchmarking at the provincial level, beyond the first years of the ETS pilot. In the previous section, we argued that the development of benchmarks at the provincial level, in particular in Hubei province, could deliver relevant information for the national Chinese ETS design. In this section, we show that the national Chinese ETS design most likely will necessitate an advanced design of allocation methodologies at the provincial level.

While little is known about the design of a most likely forthcoming national Chinese ETS starting in 2015 at this stage, we can make some assumptions about possible design options and features and their relevance to the provincial level.

If we assume that the national Chinese ETS will have a classical cap-and-trade design, following the essential features of the seven ETS pilots, it is foreseeable that some key elements will be harmonised or centralised across China.

First of all, a functioning cap-and-trade system will require a transparent and functional registry. It seems a logical choice to implement a national Chinese ETS registry to facilitate the tracking of allowances, enhance transparency and reduce transaction costs. We can also assume that MRV rules will be centralised. This is important to ensure that “one tonne” of CO$_2$ emissions reflects the same amount across China and to ensure confidence in the reported and verified emission data and hence the overall market function. It is possible, however, to have centralised MRV rules but devolved implementation and enforcement to the provincial level. This is similar to how these rules are implemented under the EU ETS, with significant implementation responsibilities given to the EU Member States. In this regard, however, it must be stressed that the lack of compliance enforcement powers in most of the ETS pilots at the provincial level is a concern for the proper functioning of these systems. This is a legal gap that should be addressed within the design of national Chinese ETS legislation.

However, with regard to cap setting and allocation methodologies under a national system, a few interesting options are possible. We present here the outline of some of these design choices, how they relate to the provincial level in China and how these compare to the current and previous states of the EU ETS.

The most centralised option would be to set one national cap on sectors covered by a Chinese ETS and establish uniform allocation methods. The provincial authorities would still handle the actual implementation of these rules, such as the calculation of the amount of allowances for each company. This approach is very similar to the functioning of the EU ETS as from 2013, as we outlined in Chapter 2.

A second option is a system with a national emissions cap that is shared among provinces in different proportions. This would allow diversification of the emissions cap among provinces with different development stages. In the EU, this approach is used for the allocation of national emission targets for non-EU ETS sectors, as highlighted in Chapter 2. The EU model uses GDP/capita as the most important indicator in this effort sharing. A differentiated target or cap setting among Chinese provinces would also be a logical
continuation of the way carbon intensity (and other economic) goals are set in the 5-year plans. For instance, the 11th 5-year plan carbon intensity goals are differentiated among the Chinese provinces.

This option can be implemented under different forms. The most centralised approach would set binding allocation rules and methods for each province. This can relate to the level of auctioning of allowances, the use of harmonised benchmarks the relative size of the new entrants/capacity and government reserves. However, provinces facing different emission caps for the covered sector should still retain some degree of liberty in the implementation of these common allocation rules.

A more flexible approach where the central government simply offers guidance for the implementation of the provincial cap can also be considered. In this case, the provincial authorities would retain most of the responsibility for the implementation of the allocation rules, under a centralised determined cap.

A fourth option would be a pure bottom-up approach in which the provincial level is free to set its emissions cap for the ETS-covered companies together with the allocation rules following national guidance. These plans could then be evaluated by the central government and corrected if needed. This approach would be similar to the first pilot years of the EU ETS (2005-2007).

We acknowledge that the above outlined options are only part of a non-exhaustive list of possibilities. They should, however, reflect some of the major policy choices that need to be considered when designing a national ETS. The table below gives an overview of the options we considered in this paper.

**Table 8. Overview of benchmarking options for allowance allocation in the Hubei ETS**

<table>
<thead>
<tr>
<th>National level</th>
<th>Provincial level</th>
<th>Comparison with EU ETS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Chinese cap for ETS sectors and common allocation rules</td>
<td>Implementation of common rules (e.g. benchmarks, auctioning, ...) at provincial level</td>
<td>This is similar to current EU ETS approach (2013-2020)</td>
</tr>
<tr>
<td><strong>Option 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National cap for ETS sectors but implemented through differentiated provincial caps (e.g. using GDP/capita effort sharing) but with common allocation “rules”</td>
<td>Implementation of common allocation rules (e.g. benchmarks, auctioning, ...) at provincial level</td>
<td>This approach would be the hybrid form of the EU ETS (2005-2012) and current EU ETS (2013-2020)</td>
</tr>
<tr>
<td><strong>Option 3</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
Analysis of the possible use of benchmarks for the allocation of allowances in the Hubei Province pilot ETS and the relevance for a national Chinese ETS

<table>
<thead>
<tr>
<th>National cap for ETS sectors but differentiated caps among provinces (e.g. using GDP/capita effort sharing) and common allocation “guidance”</th>
<th>Development of provincial allocation rules (e.g. benchmarks, auctioning ...)</th>
<th>This would reflect the EU ETS in the period 2008-2012 that included stronger guidance by the European Commission</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 4</strong></td>
<td><strong>Bottom up cap setting at provincial level (including provincial allocation rules) but with national guidance and assessment</strong></td>
<td>The provincial level would be responsible for the cap-setting and the allocation rules</td>
</tr>
</tbody>
</table>
7. Conclusions

This paper introduced the concept of benchmarking as an allocation method under a cap and trade system. We explored the EU ETS benchmarking development and allocation model and looked at a possible application of this model under the Hubei pilot ETS.

We conclude that in the short term (i.e. within two years) an EU ETS benchmarking approach under the Hubei ETS would be difficult. This is mainly due to the lack of verified data at the installation level. The Hubei ETS functions at company level, with installation-level aggregated data. Since the Hubei ETS will begin in 2014, no verified emissions and activity data at the installation level are available. However, with the right monitoring, reporting and verification provisions in place for both CO₂ emissions data and activity (production) data, Hubei province should be able to implement an EU ETS type benchmarking methodology within two to three years’ time. This approach can be relevant for the forthcoming development of the Chinese National ETS.

In this paper, we also looked at alternative approaches for the development of benchmarks, which might be applicable in the near-term. Particularly for the cement sector and the power sector, external data sources and reports can be used as proxies for an EU ETS-type benchmark. In particular the “Getting the Numbers Right (GNR)” global cement sector database developed by the World Business Council for Sustainable Development offers interesting data and benchmarking style curves that could inform the use of benchmarks for the cement sector in Hubei province. For the power sector, the development of benchmarking curves can be relevant to assess the evolution of carbon intensity at the provincial level. However, the strict power price regulation in China limits the effectiveness of a cap-and-trade system that includes the power sector. The Hubei ETS addresses this issue through both direct and indirect allocation of allowances related to electricity production to both the power plants and the electricity consumers, which should encourage consumers to reduce power consumption. Regardless of the restriction in the power sector from passing through the carbon price, benchmarks can be relevant for allowances allocation to new entrants to the ETS (under the form of increasing the capacity of existing installations). Setting ambitious but technically feasible benchmarks for new plant capacity could give plant operators an incentive to invest in best practice technologies. This is extremely relevant for the longer-term reduction of carbon intensity in the province.

While the seven Chinese ETS pilots may transition into a national Chinese ETS after 2015, the role of provincial authorities in the implementation of a national trading system can still be very important. In this paper, we presented several design options for a national Chinese ETS regarding the setting of the cap and on the allocation of allowances. Under most options, the provincial government would still have significant responsibilities in implementing nationally determined allocation methods and caps or designing provincial allocation methods under a nationally determined provincial cap. This is relevant in regards to the possibility of Hubei province developing industrial benchmarks. Hubei-based benchmarks will be relevant for China due to the economic development stage of the province, which is reflective of the overall Chinese development stage and industrial structure. Depending on the design choices made at the national level, it is even possible that Hubei-designed benchmarks could endure as part of the provincial implementation of a national Chinese ETS.
8. References


ANNEX I: Emission and activity data collection for cement production

1. Emission Data Collection

1.1. Introduction

Direct emissions are emissions from sources that are owned or controlled by the reporting entity. In cement plants, direct CO₂ emissions result from the following sources:

A. Calcination processes (calcination of carbonates, and combustion of organic carbon contained in raw materials)

B. Combustion processes

   a. Combustion of kiln fuels related to clinker production:
      - Combustion of conventional fossil kiln fuels;
      - Combustion of alternative fossil kiln fuels and mixed fuels with biogenic carbon content;
      - Combustion of biomass fuels and biofuels (including biomass wastes);
   
   b. Combustion of non-kiln fuels:
      - Combustion of conventional fossil fuels;
      - Combustion of alternative fossil fuels and mixed fuels with biogenic carbon content;
      - Combustion of biomass fuels and biofuels (including biomass wastes);
   
   c. Combustion of fuels for on-site power generation.
   
   d. Combustion of the carbon contained in wastewater.

1.2. Process emissions

The most difficult CO₂ emission calculation is involved in the calcination process. Calcination is the release of CO₂ from carbonates during pyro-processing of the raw meal. Calcination CO₂ is directly linked with clinker production. In addition, calcination of cement kiln dust (CKD) and bypass dust can be a relevant source of CO₂ where such dust leaves the kiln system for direct sale, addition to cement or other products, or for discarding as a waste.

CO₂ is released from carbonates during the pyro-processing of the raw meal. There are four possible means to obtain the emissions data from raw material calcination. Two are input methods, and the other two are output methods.

Input methods: **Amount of the raw meal consumed**

   A1: Simple input method based on analysis of the loss on ignition (LOI) of raw meal
   
   A2: Detailed input method based on analysis of the CO₂ content of raw meal (Input CO₂ balance)

Output methods: **Amount of clinker produced**
B1: Simple output method based on a standard calcination CO$_2$ emission factor (CSI default: 525 kg CO$_2$/t clinker)

B2: Detailed output method based on CaO and MgO analysis of clinker and input materials (corrected calcination CO$_2$ emission factor)

**Table:** Parameters and proposed data sources for calculation of direct CO2 emissions. (Need to establish default CO2 emission factors of fuels or use WBCSD default factors.)

<table>
<thead>
<tr>
<th>CO2 from raw materials: Methods based on raw material input (A1, A2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emission components</strong></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Calcination of raw material consumed for clinker production</td>
</tr>
<tr>
<td>Calcination of dust</td>
</tr>
<tr>
<td>Furthermore for detailed input method (A2)</td>
</tr>
<tr>
<td>Additional raw materials not included in kiln feed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO2 from raw materials: Methods based on clinker output (B1, B2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emission components</strong></td>
</tr>
<tr>
<td>--------------------------</td>
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<tr>
<td>Calcination of raw material consumed for clinker production</td>
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<tr>
<td>Calcination of dust</td>
</tr>
<tr>
<td>Organic carbon in raw materials</td>
</tr>
<tr>
<td>Furthermore for detailed output method (B2)</td>
</tr>
</tbody>
</table>
### Analysis of the possible use of benchmarks for the allocation of allowances in the Hubei Province pilot ETS and the relevance for a national Chinese ETS

#### Corrections of emission factor clinker

<table>
<thead>
<tr>
<th>Source of Ca and Mg</th>
<th>Mass fractions</th>
<th>Measured at plant level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaO + MgO from noncarbonated sources in raw materials</td>
<td>mass fractions</td>
<td>Measured at plant level</td>
</tr>
<tr>
<td>Ca + Mg silicate sources in raw materials (e.g. as part of clay minerals)</td>
<td>mass fractions</td>
<td>Measured at plant level (e.g. with XRD with Rietveld refinement)</td>
</tr>
</tbody>
</table>

#### CO2 from kiln and non-kiln fuel combustion:

<table>
<thead>
<tr>
<th>Fuel Consumption</th>
<th>Lower Heating Value</th>
<th>Emission Factor</th>
<th>Emission Factor (CO2)</th>
<th>Measured at plant level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional fuels</td>
<td>Fuel consumption</td>
<td>Lower heating value</td>
<td>Emission factor</td>
<td>t CO2 /GJ fuel</td>
</tr>
<tr>
<td>Alternative fossil fuels (fossil AF) and mixed fuels</td>
<td>Fuel consumption</td>
<td>Lower heating value</td>
<td>Biogenic carbon content</td>
<td>t CO2 /GJ fuel</td>
</tr>
<tr>
<td>Biomass fuels (biomass AF)</td>
<td>Fuel consumption</td>
<td>Lower heating value</td>
<td>Biogenic carbon content</td>
<td>t CO2 /GJ fuel</td>
</tr>
</tbody>
</table>

The choice between the simple and the detailed method depends on both the intended use of reporting and the availability of data. The detailed reporting methods are preferred, if the data required for the more detailed methods can be made available with sufficient accuracy and within the limits of practicability.

Generally, companies are encouraged to measure the required parameters at installation level. Where installation or company-specific data is not available, the recommended, international default factors should be used. Other default factors (e.g., national) may be preferred to the international defaults if deemed reliable and more appropriate. The following section provides guidance for choosing between different methods for reporting CO2 emissions from raw material calcination.

On plant level, calcination CO2 can basically be calculated in two ways: based on the volume and carbonate content of the raw meal consumed (input method), or based on the volume and composition of clinker produced (output method) plus dust leaving the kiln system. The clinker-based method is used in Europe. Both input and output based methods are included in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Output Tier 1 and 2, Input Tier 39) and the Guidelines for Monitoring and Reporting of Greenhouse Gas Emissions (MRG) 5 in the European Emission Trading System (EU ETS, Input Method A, Output Method B).

Input and output methods are, in theory, equivalent. The WBCSD/CSI decided to include both types of methods in the Protocol Version 3 spreadsheet. Companies may choose to apply the raw meal-based input method or the clinker based output method. The choice should be made according to the availability of adequate data and measurements of the mass flows. Furthermore, the spreadsheet allows for each type applying a simple and a detailed method.
The detailed reporting methods is preferred, if the data required for the more detailed methods can be made available with sufficient accuracy and within the limits of practicability. Possible sources of error such as direct additions of carbonate containing materials to the kiln, internal recycling of dust, as well as incomplete calcination of dust leaving the kiln system shall be accounted for.

In the enclosed spreadsheet mass flows and parameters of the raw meal, kiln feed, CKD, bypass dust and clinker refer to a dry state (< 1 percent humidity). Normally, the residual moisture of these materials is negligible when measurements are performed in the process of the kiln system. The CO₂ emissions from the calcination of relatively small amounts of carbonates in fuel ashes added to the kiln system shall be completely accounted by the reporting of fuel CO₂ emissions. Normally, this is assured by determining the CO₂ emission factors for fuels based on the total carbon content (TC) of the fuels, which includes both total organic carbon (TOC) and total inorganic carbon (TIC). Materials with high contents of both TOC and TIC (e.g. municipal sewage sludge) can be regarded as fuel and/or raw material. In any case, the complete CO₂ emissions resulting from their use shall be accounted.

1.3. Combustion emissions

A number of fuel types are combusted in cement kilns. As described above, combustion takes place in cement plants in the following four combustion processes:

- Combustion of kiln fuels related to clinker production;
- Combustion of non-kiln fuels (see Section 3.8);
- Combustion of fuels for on-site power generation;
- Combustion of the carbon contained in wastewater.

Historically, the cement industry has used coal and petroleum coke (petcoke) and these are standard fuels for the sector. However, the industry has the technical ability to make use of a wide range of substitute fuels including tires, fuel derived from municipal and industrial waste, waste liquid solvents and biomass.

One way that the cement sector (like many other sectors) may choose to reduce its net emissions of CO₂ is through the use of biofuels. The level of substitute fuels burnt in cement kilns is expected to continue to rise across the EU due to economic pressures and legislative developments (such as the Landfill Directive). Cement operators sometimes charge a gate fee to accept waste and at the same time reduce their costs for purchasing fossil fuels.

To obtain emissions data from combustion in cement production the following data is required for each combustion process:

<table>
<thead>
<tr>
<th>Fuel consumption data:</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of fuel used</td>
<td>t / year</td>
</tr>
<tr>
<td>Net calorific value (NCV)</td>
<td>GJ / t</td>
</tr>
<tr>
<td>Emission factor</td>
<td>t CO₂ / TJ</td>
</tr>
<tr>
<td>Oxidation factor</td>
<td>%</td>
</tr>
</tbody>
</table>
2. Activity Data collection

2.1. Introduction

The EU ETS has used two starting points on allocation principles for activity levels, and they were based on the requirement of a full ex-ante distribution of allowances to incumbents. These starting points were:

- Use historical production figures to allocate allowances to existing installations;
- Use product-specific capacity utilization rates (e.g. based on the historic production rates of a sector) with verifiable capacity data to allocate allowances to new installations.

The EU has set standard capacity utilization rate for purposes of allocating allowances to new installation as 80-percentile of the average annual capacity utilization of all installations producing the product concerned. As part of the overall baseline data collection for incumbent installations carried out for the establishment of the National Implementation Measures (NIMs), Member States collected data on the average annual production of the product concerned in the given period. By dividing these production figures by the initial installed capacity, Member States then determined, on this basis, the capacity utilization factors of the relevant installations on their territory.

The use of historical data from before the adoption of Hubei ETS limits the period to before or including 2013. The desire to use data of good quality does not allow going too far into the past. Thus, the period 2010-12 might be the most suitable reference period to be used, because data for 2013 may not be available in time for the allocation decision.

There are four situations that can impact how activity data is at the end determined for each installation:

1. Normal situation: the installation (or company) has experienced continuous activity throughout all baseline years.
2. Interrupted activity. The company had for some reasons (unscheduled maintenance, accident, natural disasters, etc.) interrupted its output level, which could negatively impact its allocation if not taken into account.
3. Start of operation during the baseline period. The company began to operate its installation during the baseline period.
4. Significant capacity changes. This can mean both activity levels above or below a normal situation.

2.2. Normal Situations

Most installations in the Hubei ETS will likely fall into the first category. (i.e. the companies and their installations have operated under normal or near normal circumstances for the duration of the baseline period.)
As an example, in the EU ETS, the starting date of normal operation is defined as the first day of the earliest continuous 90-day period during which the activity level of the first of the sub-installations in the installation carrying out ETS activities—aggregated over the 90-day period—is at least 40 percent of the design capacity.

The activity level is calculated by adding up the total activity level in the 90-day period and dividing this by the daily capacity of the sub-installation multiplied by 90. The activity level does not need to be above the 40 percent during each day in the 90-day period.

The design capacity is determined at sub-installation level reflecting the capacity of the sub-installation under normal operation. The design capacity needs to be determined on the basis of project documentation and on the guaranteed values given by the supplier. Relevant documents could be reports—the ones accompanying the project-, datasheets, guaranteed performance values. The continuous 90-day period is to be understood as period of 90 consecutive days in which the relevant sub-installation is operated each day. In case the sector's usual production cycle does not foresee such continuous 90-day periods, the sector-specific production cycles are added to a 90-day period. For the purpose of determining the start of normal operation, the activity level should be considered at a daily basis. The start of normal operation has to be verified by an independent verifier and approved by the relevant Competent Authority.

In this case the obvious choice for determining the activity level will be to use either the highest production levels in one of those years or the average production level over the three years. EU Member States have used both methods. Both methods are correct to some extent for specific reasons, and may not be suitable for other reasons.

The Competent Authority of Hubei will need to apply methodologies for when the situation with a particular company has not been normal, as in case 2, 3, or 4. The following are possible rules for determining activity data that will not fall into the normal situation.

### 2.3. Interrupted activity

The CA will first need to set the cut off interruption period. How long will an installation need to be out of production to qualify for special treatment? This period can be one day, one week, or whatever the CA determines. Next, the year when the interruption has occurred is skipped, and only the remaining years are used to determine the activity level.

*Start of operation during the baseline period so that there are less than two years to choose from.*

The approach for sub-installations that are part of an installation that started operation within the baseline period such that there are no two calendar years of operation in the chosen baseline period the relevant capacity utilization factor can be set based on:

- The installations intended normal operation
- The maintenance cycle
- Common production cycle
- Energy efficient techniques (for fuel and heat benchmark sub-installations)
- GHG efficient techniques (for process emissions sub-installations)
For this approach, stringent data quality practices are necessary, including:

- Plausibility: Should be checked against typical utilization rates in the sector concerned
- Values > 100 percent should not be accepted
- All data should be independently verified

### 2.4. Significant capacity changes

This is the most difficult case to develop accurate methodology for. The CA need to first determine what constitutes a significant capacity change. Second, methodology is needed to determine capacity.

As to the first question, the EU has defined a significant capacity change that is:

a) Physical change at the installation concerned AND changed capacity at least 10 percent of initial capacity (determined prior to physical change); or

b) Physical change at the installation concerned AND a changed activity level that would lead to a change in allocation of at least 50,000 allowances per year representing at least five percent of original allocation.

The second question is more complex. Capacity is needed for product benchmark sub-installations, for sub-installations of on installation that operated less than 2 years in the baseline period, and sub-installation before and after a significant capacity change.

There are two ways to determine capacity:

- Average of two highest monthly activity levels in a period x 12 months per year
- Experimental verification (48 hours continuous test)

The start of changed operation could be determined following a stepwise approach (taken from the EU ETS methodology) for significant capacity **extensions** and **reductions**.

For significant capacity extension:

1. Determine added design capacity.
2. Determine activity level related to added capacity based on actual activity level of extension.
3. Start of changed operation is the first day of a 90-day continuous period in which:

   \[ \text{Activity Level} \geq \text{Added Design Capacity} \times 0.4 \]

For significant capacity reductions

1. Determine remaining design capacity.
2. Determine activity level related to remaining design capacity.
3. Start of changed operation is the first day of a 90 day continuous period in which:

   \[ \text{Activity Level} \geq \text{Remaining Design Capacity} \times 0.4 \]

The EU ETS has adopted some common sense rules and guidelines for the relation between the physical change and the capacity change. These can be summarized as follows:
- There should be a causal relation between physical changes and capacity changes.
- A physical change can only lead to one capacity change per sub-installation.
- One significant change in capacity can be the result of multiple physical changes.
- There can be a long time between the physical change and the significant change in capacity.
- Physical change in the baseline period could lead to capacity change after the baseline period.
- Measures that exclusively aim at increasing efficiency and not increasing output should not be regarded as physical changes.
ANNEX II: Emissions and Activity Data Collection for Power Production and Combined Heat and Power

1. Emissions Data

In electricity production, the following factors influence specific CO₂ emissions:

- Choice of fuel mix
- Efficiency of fuel conversion to electricity

For all calculations regardless, the following data will be needed to calculate CO₂ emissions:

<table>
<thead>
<tr>
<th>Fuel consumption data:</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of fuel used</td>
<td>t / year</td>
</tr>
<tr>
<td>Net calorific value (NCV)</td>
<td>GJ / t</td>
</tr>
<tr>
<td>Emission factor</td>
<td>t CO₂ / TJ</td>
</tr>
<tr>
<td>Oxidation factor</td>
<td>%</td>
</tr>
<tr>
<td>Biomass content (as fraction of carbon)</td>
<td>%</td>
</tr>
<tr>
<td>Emissions (fossil, calculated)</td>
<td>t CO₂ / year</td>
</tr>
<tr>
<td>Energy Input (calculated)</td>
<td>TJ / year</td>
</tr>
</tbody>
</table>

From the table it is clear that the calculation of emissions in power generation is a straightforward process involving the following equation:

\[
\text{Emissions} = \text{Amount of fuel (t/year)} \times \text{NCV (GJ/t)} \times \text{emissions factor (t CO₂/GJ)} \times \text{oxidation factor}
\]

The only possible issue is the oxidation factor. This factor expresses the ratio of carbon oxidized to CO₂ as a consequence of combustion to the total carbon contained in the fuel, expressed as a fraction, considering CO emitted to the atmosphere as the molar equivalent amount of CO₂. The higher the factor is, the higher the specific emissions will be.

Standard default oxidation factor for all fuels suggested by the IPCC Good Practice Guidance (2006) is 1. This number assumes that all carbon in the fuel is emitted in the form of CO₂ during combustion. For liquid and gaseous fuels in power generation it is generally accepted to use this default standard oxidation factor of 1.

For coal, many installations will have lower oxidation factor, due to the nature of coal combustion and/or the state of the combustion technology. In the absence of other data, it is possible to use standard oxidation factor (1) as well, however, if the reporting entity can support with data its own oxidation factor (because, for example, the entity uses old boilers that leave a greater fraction of carbon un-oxidized), that
entity can be allowed to use its own oxidation factor. In this case, its reported emissions would be lower than an entity using the same amount of fuel but a default oxidation factor.

China has reported in its Second National Communication that it had carried out “sample tests of carbon oxidation factors for power plant boilers and industrial boilers” and that “the carbon oxidation factors of coal-fired equipment, especially the industrial boilers and kilns, vary largely.” The communication does not provide the actual oxidation factors. It is possible that since the oxidation factors were found to vary in industrial boilers and kilns, they could be more unified in power plants.

In the absence of good specific data on oxidation factors from Hubei province, it is recommended that the Hubei ETS regulator uses fuel-specific emission factors that already include the oxidation factor (1 or other assumed factors for coal). This will simplify reporting and monitoring procedures. For coal the national factor assumed in the Second National Communication could be used.

2. Activity Data

The principles for power sector activity data collection is the same as for the cement sector. The EU has used two starting points on allocation principles for activity levels, and they were based on the requirement of a full ex-ante distribution of allowances to incumbents. These starting points were:

- Use historical production figures to allocate allowances to existing installations, and
- Use product-specific capacity utilization rates (e.g. based on the historic production rates of a sector) with verifiable capacity data to allocate allowances to new installations.

Experience from on power sector the EU varies. First of all, the EU does not allocate to the power sector, with the exception of the new member states from Eastern Europe, who have negotiated derogation for the power sector. In those cases, allocation is based on grandfathering, not on benchmarking. Power sector benchmarks in the EU therefore do not exist. Each country has a little different grandfathering approach. In the Czech Republic, for example, the allocated volume is based either on the mean electricity production values during 2005-2008, or on average values during 2009-2010. The choice whether to go for the mean or average is made by the installations.

For new installations, The EU has set standard capacity utilization rate for purposes of allocating allowances to new installation as 80-percentile of the average annual capacity utilization of all installations producing the product concerned. As part of the overall baseline data collection for incumbent installations carried out for the establishment of the National Implementation Measures (NIMs), Member States collected data on the average annual production of the product concerned in the given period. By dividing these production figures by the initial installed capacity Member States then determined, on this basis, the capacity utilization factors of the relevant installations on their territory.

The use of historical data from before the adoption of Hubei ETS limits the period to before or including 2013. The desire to use data of good quality does not allow going too far into the past. Thus, the period 2010-12 might be the most suitable reference period to be used, because data for 2013 may not be available in time for the allocation decision.
As with the cement sector, there are four situations that can impact how activity data is at the end determined for each installation:

1. Normal situation: the installation (or company) has experienced continuous activity throughout all baseline years.
2. Interrupted activity. The company had for some reasons (unscheduled maintenance, accident, natural disasters, etc.) interrupted its output level, which could negatively impact its allocation if not taken into account.
3. Start of operation during the baseline period. The company began to operate its installation during the baseline period.
4. Significant capacity changes. This can mean both activity level above or below a normal situation.

2.1 Normal Situations

Most installations in the Hubei ETS will likely fall into the first category. (i.e. the power plants and their installations have operated under normal or near normal circumstances for the duration of the baseline period.)

As an example, in the EU ETS, the starting date of normal operation is defined as the first day of the earliest continuous 90 days period during which the activity level of the first of the sub-installations in the installation carrying out ETS activities – aggregated over the 90 days period – is at least 40% of the design capacity

The activity level is calculated by adding up the total activity level in the 90 days period and dividing this by the daily capacity of the sub-installation multiplied by 90. The activity level does not need to be above the 40% during each day in the 90 days period.

The design capacity is determined at sub-installation level reflecting the capacity of the sub-installation under normal operation. The design capacity needs to be determined on the basis of project documentation and on the guaranteed values given by the supplier. Relevant documents could be reports - the ones accompanying the project-, datasheets, guaranteed performance values. The continuous 90 days period is to be understood as period of 90 consecutive days in which the relevant sub-installation is operated each day. In case the sector’s usual production cycle does not foresee such continuous 90 days periods, the sector-specific production cycles are added to a 90 days period. For the purpose of determining the start of normal operation, the activity level should be considered at a daily basis. The start of normal operation has to be verified by an independent verifier and approved by the relevant Competent Authority.

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The Competent Authority of Hubei will need to apply methodologies for when the situation with a particular company has not been normal, as in case 2, 3, or 4. The following are possible rules for determining activity data that will not fall into the normal situation.
2.2 Interrupted activity

The CA will first need to set the cut off interruption period. How long will an installation need to be out of production to qualify for special treatment. This period can be one day, one week, or whatever the CA determines. Next, the year when the interruption has occurred is skipped, and only the remaining years are used to determine the activity level.

*Start of operation during the baseline period so that there are less than 2 years to choose from.*

The approach for sub-installations that are part of an installation that started operation within the baseline period such that there are no two calendar years of operation in the chosen baseline period the relevant capacity utilization factor can be set based on:

- The installations intended normal operation
- The maintenance cycle
- Common production cycle
- Energy efficient techniques (for fuel and heat benchmark subinstallations)
- Greenhouse Gas efficient techniques (for process emissions subinstallations)

For this approach, stringent data quality practices are necessary, including:

- Plausibility: Should be checked against typical utilization rates in the sector concerned
- Values > 100% should not be accepted
- All data should be independently verified

2.3 Significant capacity changes

This is the most difficult case to develop accurate methodology for. The CA need to first determine what constitutes a significant capacity change. Second, methodology is needed to determine capacity. As to the first question, the EU has defined a significant capacity change that is:

a) Physical change at the installation concerned AND changed capacity at least 10% of initial capacity (determined prior to physical change); or

b) Physical change at the installation concerned AND a changed activity level that would lead to a change in allocation of at least 50 000 allowances per year representing at least 5% of original allocation.

The second question is more complex. Capacity is needed for product benchmark sub-installations, for sub-installations of on installation that operated less than 2 years in the baseline period, and sub-installation before and after a significant capacity change.

There are two ways to determine capacity:

- Average of 2 highest monthly activity levels in a period x 12 months per year
- Experimental verification (48 hours continuous test)

The start of changed operation could be determined following a stepwise approach (taken from the EU ETS methodology) for significant capacity extensions and reductions.
For significant capacity extension:

1. Determine added design capacity
2. Determine activity level related to added capacity based on actual activity level of extension
3. Start of changed operation is the first day of a 90 day continuous period in which

\( \text{Activity Level} \geq \text{Added Design Capacity} \times 0.4 \)

For significant capacity reductions

1. Determine remaining design capacity
2. Determine activity level related to remaining design capacity
3. Start of changed operation is the first day of a 90 day continuous period in which:

\( \text{Activity Level} \geq \text{Remaining Design Capacity} \times 0.4 \)

The EU ETS has adopted some common sense rules and guidelines for the relation between the physical change and the capacity change. These can be summarized as follows:

- There should be a causal relation between physical changes and capacity changes
- A physical change can only lead to one capacity change per sub-installation
- One significant change in capacity can be the result of multiple physical changes
- There can be a long time between the physical change and the significant change in capacity
- Physical change in the baseline period could lead to capacity change after the baseline period
- Measures that exclusively aim at increasing efficiency and not increasing output should not be regarded as physical changes.

3. Special Case of Combined Heat and Power

In the EU ETS CHP plants have been the direct recipients of free allowances since the EU ETS’s inception and entry into force in 2005. With the revised EU ETS Directive, which entered into force on January 1st 2013, the rules governing free allocation of allowances have been dramatically modified. Under the new system, CHP heat produced by plants supplying installations covered by the EU ETS, as well as CHP plants included in the EU ETS but supplying non-ETS installations, is eligible for free allowances. The amount of free allowances eligible for this heat is a function of a number of factors, in particular the carbon leakage status of the heat consumer and the existence of product benchmarks for the end product using the CHP heat.

In the Hubei ETS, the benchmark for heat and for electricity produced by the same installation should be divided into two. This means one benchmark for heat and one for electricity. The reason is that allocation will be given to electricity producers that do not produce heat, and there is the basic need to maintain fair allocation for the same product.

CHP is still defined in various ways. In some countries all power and heat produced by a CHP plant is considered as CHP, whereas in the other countries CHP power and heat is only when their generation depends on each other. In other words, the CHP power is only that part of electricity generation that depends on the heat load, and likewise, the CHP heat is only when it comes out from the turbines and not
directly from the boilers. Thus, a CHP system in a district heating system should produce minimum amount of electricity in the summer when the heat load is very low (only for hot water supply, for example). On the other hand, a CHP plant can supply industrial steam all year around, and in this case the same size CHP plant could conceivable produce much greater amount of electricity.

The EU CHP Directive offers a sophisticated way to define what CHP is and how to calculate the energy savings of CHP. Electricity production from cogeneration is considered equal to total annual electricity production of the unit measured at the outlet of the main generators;

- In cogeneration units of type of combined cycle and steam condensing extraction plants of the annual efficiency at least 80 percent; and
- In cogeneration units of other types with an annual overall efficiency at a level of at least 75 percent.

In cogeneration units with an annual overall efficiency below the values referred to above the cogeneration is calculated according to the following formula:

\[ CHP_e = CHP_H \times C \]

Where:
- \( CHP_e \) is the amount of electricity from cogeneration
- \( C \) is the power to heat ratio
- \( CHP_H \) is the amount of useful heat from cogeneration (calculated for this purpose as total heat production minus any heat produced in separate boilers or by live steam extraction from the steam generator before the turbine).

The calculation of electricity from cogeneration must be based on the actual power to heat ratio. If the actual power to heat ratio of a cogeneration unit is not known, the following default values may be used, notably for statistical purposes provided that the calculated cogeneration electricity is less or equal to total electricity production of the unit:

<table>
<thead>
<tr>
<th>Type of the unit</th>
<th>Default power to heat ratio, C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined cycle gas turbine with heat recovery</td>
<td>0,95</td>
</tr>
<tr>
<td>Steam backpressure turbine</td>
<td>0,45</td>
</tr>
<tr>
<td>Steam condensing extraction turbine</td>
<td>0,45</td>
</tr>
<tr>
<td>Gas turbine with heat recovery</td>
<td>0,55</td>
</tr>
<tr>
<td>Internal combustion engine</td>
<td>0,75</td>
</tr>
</tbody>
</table>

In order to have CHP, and cogeneration, the prerequisite is to have the heat load in the form of district heating (DH) and/or industrial process load.

### 3.1 CHP emission allocation methods

As noted above, it will be necessary to assign the total emissions to the different generated energy streams (normally steam and electricity) if a company is not purchasing or selling all of the energy from a CHP plant or is not purchasing or selling the energy streams in the same proportions as they are generated.
The three most common methods to allocate emissions from a CHP plant are:

- **Efficiency method**: GHG emissions are allocated based on the energy inputs used to produce the separate steam and electricity products. The efficiency method is the preferred method of this guidance document.
- **Energy content method**: GHG emissions are allocated based on the energy content of the output steam and electricity products.
- **Work potential method**: GHG emissions are allocated based on the energy content of the steam and electricity products.

**Efficiency Method**

- Allocates GHG emissions according to the amount of fuel energy used to produce each final energy stream.
- Assumes that conversion of fuel energy to steam energy is more efficient than converting fuel to electricity. Thus, focuses on the initial fuel-to-steam conversion process.
- Actual efficiencies of heat and of power production will not be fully characterized, necessitating the use of assumed values.

**Energy Content Method**

- Allocates GHG emissions according to the useful energy contained in each CHP output stream.
- Need information regarding the intended use of the heat energy.
- Best suited where heat can be characterized as useful energy, e.g., for process or district heating.
- May not be appropriate where heat used for mechanical work because it may overstate the amount of useful energy in the heat, resulting in a low emissions factor associated with the heat stream.

**Work Potential Method**

- Allocates emissions based on the useful energy represented by electric power and heat, and defines useful energy on the ability of heat to perform work.
- Appropriate where heat is to be used for producing mechanical work (where much of the heat energy will not be characterized as useful energy).
- May not be appropriate for systems that sell hot water because hot water cannot be used, as steam can, to perform mechanical work.

In order to insure a consistent approach to CHP allocation, the efficiency method is recommended.

The following section outlines the efficiency method of allocating emissions of a CHP plant, and provides step-by-step guidance on following the efficiency method;

**3.2 Guidance on following the efficiency method**
For this method, emissions are allocated based on the separate efficiencies of steam and electricity production. To determine the share of GHG emissions attributable to steam and electricity production, the following steps are needed:

**Step 1: Determine the total direct emissions and the total steam and electricity outputs for the CHP system.** The CHP system from which steam or electricity is either purchased or sold could have multiple fuel inputs and multiple steam or electricity outputs. The different output flows should be combined into two separate values, one for steam output and one for electricity output. Furthermore, these output flows should be in the same units of energy (e.g., all expressed as GJ). Steam tables provide energy content (enthalpy) values for steam at different temperature and pressure conditions. Enthalpy values multiplied by the quantity of steam give energy output values.

**Step 2: Estimate the efficiencies of steam and electricity production.** This method is based on the assumption that conversion of fuel energy to steam energy is more efficient than converting fuel to electricity. The efficiencies are used to determine the amount of fuel input, and therefore emissions, associated with steam vs. electricity production. The use of source specific efficiency factors is recommended. However, if source specific factors are unavailable, default values can be used, which are provided in the worksheet.

**Step 3: Determine the fraction of total emissions to allocate to steam and electricity production.** The following formulas are used for this step.

\[
\frac{H}{eH} \quad E_H = \frac{H}{eH} \times E_t \quad \text{and} \quad E_P = E_t - E_H
\]

Where:

- \(E_H\) = emissions allocated to steam production
- \(H\) = steam output (energy)
- \(e_H\) = assumed efficiency of steam production
- \(P\) = delivered electricity generation (energy)
- \(e_P\) = assumed efficiency of electricity generation
- \(E_t\) = total direct emissions of the CHP system
- \(E_P\) = emissions allocated to electricity production

*Note: The use of default efficiency values may, in some cases, violate the energy balance constraints of some CHP systems. This can be checked by comparing the calculated assumed energy input with the actual energy input of the CHP plant. Assumed energy input is calculated based on the heat and power output and the assumed efficiencies as shown in the following equation.*

**Assumed Energy Input = \(\frac{H}{eH} + \frac{P}{eP}\)**

It is not a significant issue if energy balance is violated, since total emissions would still be allocated between the energy outputs. However, the user should be aware of the energy balance and if the constraints are not satisfied \(e_H\) and \(e_P\) can be modified until constraints are met.
**Step 4: Calculate emission rates for steam and electricity production.** Divide the total emissions from steam production (Step 3) by the total amount of steam produced to get an emission rate (e.g., mass CO₂/amount of steam). Divide the total emissions from electricity production (Step 3) by the total amount of electricity produced to get an emission rate (e.g., mass CO₂/amount of electricity).

**Step 5: Estimate emissions from purchases or sales.** To estimate emissions, multiply the amount of steam or electricity either purchased or sold by the appropriate emission rate (Step 4). Units used for the amount of steam or electricity purchased or sold should be the same as used to calculate the emission rates (e.g., GJ).

*Note:* Shares of emissions allocated to steam production (Eₜ) should be assigned to different heat products based on their energy content.