PRE product carbon footprint report

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The results presented in this report are unique to the assumptions and practices of PRE/Cerame-Unie. The results are not meant as a platform for comparability to companies and/or products. Even for similar products, differences in unit of analysis, use and end-of-life stage profiles, and data quality may produce incomparable results. The reader may refer to the GHG Protocol Product Life Cycle Accounting and Reporting Standard (www.ghgprotocol.org) for a glossary and additional insight into the GHG inventory process.

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List of acronyms

CCS: Carbon Capture and Storage

CHP: Combined Heat and Power

CO_2 e: Carbon Dioxide equivalent

GHG: Greenhouse Gas

HFCs: Hydrofluorocarbons

MWh: Megawatt hour

PFCs: Perfluorocarbons

PRE: European Refractories Producers Federation

Tonne: Metric tonne

1. Introduction

PRE, the European Refractories Producers Federation, is pleased to present to you its product carbon footprint methodology report and the results of its first EU-wide data collection exercise.

This document was made possible thanks to the support of the PRE members, especially those who contributed with data and expertise as well as the PRE Expert Group, who was closely involved through regular meetings throughout the year.

Last but not least, the quality of this methodology report was further enhanced by input from the Carbon Trust and we thank them for their dedicated work.

The product carbon footprint exercise is primarily intended for PRE members and their downstream customer industries to provide an EU-wide answer to questions raised on the carbon footprint of the refractory industry.

As documented in the report, this exercise is a gate-to-gate exercise, focusing on the different refractory product production stages. In this respect, it should also be noted that the specific resource consumption of European refractory products is very low, with only 10 kg of refractories required per tonne of steel.

We trust you will find this document useful and PRE remains at your disposal to answer any comments or question you may have regarding the PRE product carbon footprint.

2. Background about PRE and the refractory industry

2.1 PRE

PRE, the European Refractories Producers Federation, located in Brussels, is the European organization representing the interests of the European refractory manufacturing industry. PRE was founded in 1953 and offers a European platform on which its members can exchange views and experiences in the common interest.

PRE is a member of Cerame-Unie, representing the European ceramics industry. Further information can be found on the websites of PRE: www.pre.eu and Cerame-Unie: www.cerameunie.eu.

2.2 PRE membership

PRE unites National Associations representing 16 European countries (marked in dark grey in the figure below). Four multi-national companies are also a direct member as concerns their European activities: Calderys, Magnesita, Refratechnik and Vesuvius.

Fig. 1: Map of PRE membership

2.3 European refractory industry

Refractory products are used in all process industries requiring elevated temperatures. Refractory materials are used in linings for furnaces, kilns, incinerators and reactors.

More than half of refractory products are used in the steel industry, followed by the cement & lime and ferrous & non-ferrous industries. Refractory products are also indispensable in the ceramic and glass industry, incineration, chemical industry and many more.

In addition to the different applications and differences in the size and shape of the furnace or application, refractory products are exposed to different temperatures, and different levels of chemical and physical attack. For an optimised process, the most appropriate refractory product is required for each specific situation, resulting in a wide range comprising thousands of different products on the market.

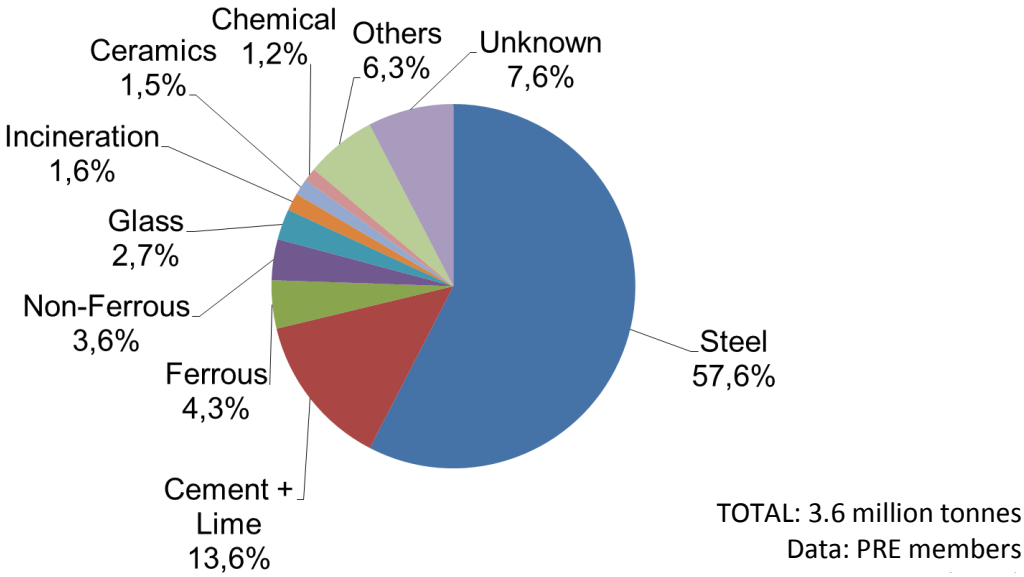
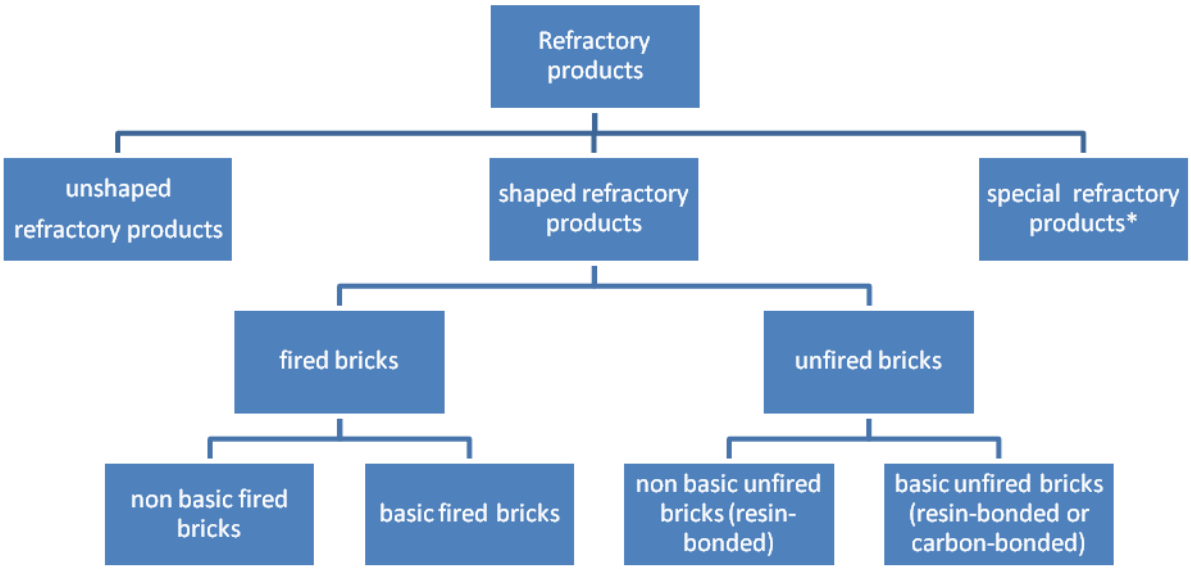


Fig. 2: End-use applications of refractory products

Classifications can be made based on shape, composition, firing temperature, application, etc. A simplified schematic overview is given in the figure below. This overview shows the aggregation of the various refractory products. Data was collected on the basis of this classification.



- including: pre-cast, iso-pressed, hydrocarbon impregnated refractories and high temperature insulation wool

Fig. 3: Schematic overview of refractory products

The European refractories industry represented by PRE produced about 4 million tonnes of refractories in 2012.

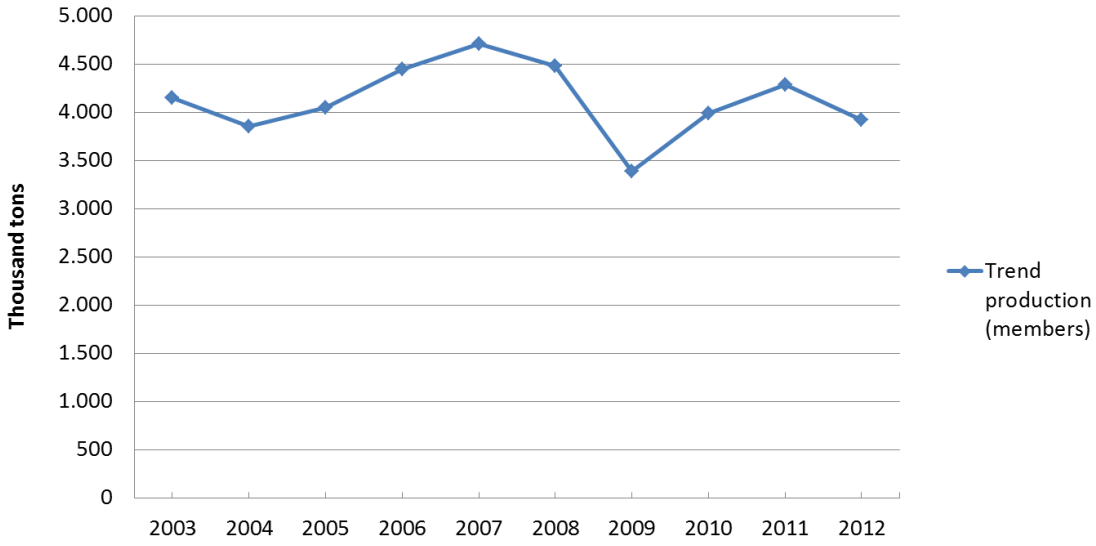


Fig. 4: Refractories production trend from 2003 to 2012 (PRE statistics)

3. Project context and objective

Environmental reporting, and more specifically carbon footprinting, has gained widespread importance over the past years in Europe and worldwide. This inspired PRE to develop a carbon footprint for refractory products.

In 2013, PRE collected data from its members and calculated the average European carbon footprint for a range of different refractory products. This report presents the context, methodology and results of the first edition of the product carbon footprinting exercise.

The outcome of this exercise provides for the first time a European carbon footprint for refractory products. It will support PRE members in their communication with their customers and help them in turn to calculate a more accurate carbon footprint for their products. It will also increase the general knowledge on the European refractories industry. Furthermore it will help the European refractories industry to analyse their individual environmental positions and serve as a framework for improvement.

This report is publicly available on the PRE website and sent to all PRE members as well as European Downstream Users associations.

The PRE product carbon footprinting exercise and reporting has been developed with reference to the GHG Protocol Product Life Cycle Accounting and Reporting Standard[1].

PRE worked together with the Carbon Trust to ensure a high quality report[2].

The assessment by the Carbon Trust can be found at the end of this report (see Annex V).

[1]For more information on the GHG Protocol: www.ghgprotocol.org
[2]For more information on Carbon Trust : www.carbontrust.com

4. Scope

4.1 Geographical scope

Countries belonging to the EU-27, the four countries of the European Free Trade Association (Norway, Switzerland, Iceland and Liechtenstein) as well as the countries where PRE is represented through a National Association (see chapter 2.2), are included in the data collection exercise.

4.2 Product scope

In accordance with the general classification of refractory products (see chapter 2.3) data has been collected for eight different product groups:

1: Fired basic shaped

- Magnesia
- Magnesia chromite
- Magnesia spinel
- Magnesia-zircon/zirconia
- Dolomite

2: Fired non basic shaped

- Silica
- Fireclay
- High alumina
- Silicon carbide
- Calcium aluminate
- Zircon-containing

3: Unfired basic shaped (resin- or carbon bonded)

4: Unfired non -basic shaped (resin bonded)

5: Unshaped

6: Pre-cast

7: Iso-pressed

8: Hydrocarbon impregnated

Further subdivisions have been made for the two categories of fired products. These subdivisions have been based on the different raw materials used. This allows the combination of the carbon footprint data of the specific raw materials with the carbon footprint data of the related refractory products. As explained in chapter 4.3, this product carbon footprint exercise is a gate-to-gate exercise focusing on the refractory production processes. Companies were allowed to report just the total if information on each of the subdivisions was not available.

For unfired and unshaped products, such subdivisions are not made as the gate-to-gate product carbon footprint for these products is estimated to be so low that the variation between the different subdivisions would be marginal compared to the impact of the input materials.

4.3 System boundaries and process steps

The data collection exercise only focuses on primary data as these are the data for which the refractory companies are directly responsible. For this reason, this questionnaire does not include questions on raw materials or processes further down the supply chain.

Eight different process steps have been identified in the data request:

- Crushing- screening
- Weighing – batching
- Mixing
- Shaping
- Thermal processing
- Finishing
- Packaging
- Other

More details on the scope of this exercise are found in the refractory process map in Annex I.

Energy consumption related to these process steps has been collected. The energy consumption for those locations which are exclusive office locations or where no production takes place (e.g. only R&D), have not been collected.

This first data collection exercise is a gate-to-gate exercise. Data was collected at individual site level. For the cases where the first production steps take place at one site and the product is finalised at another site, the production steps are added together so that the full production chain is covered in the reporting. Transport between the sites is not reported.

4.4 CO_2 equivalent

The GHG Protocol Product Standard covers six different greenhouse gasses. In addition to CO_2, it also takes into account CH_4, N_2O, SF_6, HFCs and PFCs. The product carbon footprint calculated by PRE and presented in this report will therefore be presented as tonne of CO_2 equivalent per tonne of product.

During the process steps mentioned in chapter 4.3, there is no usual or intended release of greenhouse gases other than CO_2. Process emissions of all GHGs have been considered but only the CO2 process emissions have been collected through a separate column in the questionnaire. These process emissions are calculated based on the stoichiometric calculations on the input material. The same approach is commonly used in industries that make reports on process emissions under the EU ETS reporting or following other reporting requirements arising from national legislation.

With regard to the fuel emissions, fuel conversion factors were used which taken into account the typical emissions from all six greenhouse gases emitted during combustion of the different fuels as well as the upstream emissions related to these fuels. These fuel conversion factors have been provided by the Carbon Trust and are listed in Annex IV.

4.5 CO_2 neutral fuel sources and the use of CHP

In order to get the full picture on the carbon flow, the data collection questionnaire included additional questions related to the use of CHP in the refractory industry and asked if the manufacturing location contributed to the removal of GHG emissions (e.g. through carbon capture and storage). In addition, energy consumption from CO_2 neutral fuel sources was reported separately.

As mentioned in chapter 6, no CHP or CO_2 neutral fuels are used in the refractory industry. This can be explained by the fact that these technologies or fuels are not available for the high temperature processes used in the refractory industry.

5. Methodology

5.1 Process

PRE developed a detailed product carbon footprint methodology in line with the official Greenhouse Gas Protocol Product Standard (see chapter 3). This exercise was carried out in collaboration with the UK Carbon Trust as a consultant. An ad-hoc group of experts was created from PRE to steer the project, which had received full support from the PRE General Assembly.

An essential part of the methodology was to set up an extensive data collection exercise amongst PRE members. For this purpose, a detailed sector guide and questionnaire (in excel) were developed. Members had two months to report. Data was collected on the Energy Intensity (MWh/tonne) for each individual fuel source. This allowed PRE to calculate the energy intensity and CO_2 equivalent carbon footprint, based on the European fuel conversion factors provided by the Carbon Trust (see Annex IV). For reasons of confidentiality, some multinational companies did not disclose the country, which prevented the use of national conversion factors.

5.2 Specifications

In addition to the system boundaries and process steps detailed in chapter 4.3, the following specifications were given in the sector guide accompanying the questionnaire.

Data sources:

In accordance with the GHG Product Standard, the carbon impact of processes controlled directly by the refractory companies must be calculated based on primary data. The data requested from PRE members covered energy consumption for each process step and the total volume of products packed, ready-to-ship, broken down by product (sub)-grouping. Reporting was carried out at plant level in order to maximize the number of data points to assess the variability of the results.

Reporting period:

Data has been reported for a rolling (continuous) 12 month period between January 2011 and December 2012.

Reference flow:

The reference flow for production data is the total volume of packed ready-to-ship products produced during the reporting period. This ensures that any production waste is accounted for appropriately. The reference flow also enabled PRE to calculate a weighted average product carbon footprint.

Reporting value:

The values of energy consumption for the different energy carriers and process steps have been reported in MWh for the total reference flow.

The CO_2 process emissions have been reported in tonnes of process CO_2 emitted for the total reference flow.
The reference flow has been reported in metric tonnes of packed ready-to-ship products, produced during the reporting period.

Energy conversion factors:
For the conversion of fuel sources (expressed e.g. in kg/tonne or Nm^3/tonne) to kWh/tonne of fuel, site specific energy conversion factors have been used based on the lower calorific value (i.e. useful heat) provided by the supplier of the energy source. When these factors were not available, the generic factors provided in the 'energy conversion factors' sheet have been used (see Annex III).

Energy carrier:
PRE has calculated the CO_2 footprint from the reported MWh and tonnage based on the specific energy carrier for each of the reported values. For this purpose, energy consumption data has been collected separately for each energy carrier (natural gas, coke oven gas, electricity, oil, diesel, LPG ...).

Source of info:
All reported data has been labelled according to different levels of accuracy: measured (M), calculated (C), and estimated (E), secondary/literature (S).
“Measured” included the quantification of e.g. natural gas consumption done by standard cubic meters, even if the energy amount was calculated on the basis of the lower energy content.
“Calculated” included the quantification of e.g. electricity done by nominal capacity and the running hours of a motor.

5.3 Confidentiality

All data has been collected by the PRE secretariat and kept confidential. Only weighted averages have been communicated. These weighted averages were only calculated if a minimum of three replies (manufacturing locations) were received for the product group and process step in question.

In order to increase confidentiality at company level, respondents had the option to reject the inclusion of their data if less than 3 companies reported for the given product group and process step.

6. Results and analysis

6.1 Representativeness

Data has been received from 40 different sites, located Europe wide. These sites belong to 10 different legal entities, including a mix of multinational companies and SMEs.

Out of a PRE membership of 16 countries/regions, 11 have been covered, including: Austria, Belgium, the Czech Republic, France, Germany, Italy, Poland, Scandinavia, Spain, the Slovak Republic and the UK.

Data collected covers a production of about 1.7 million tonnes. Data has been reported for a 12 month period between January 2011 and December 2012. According to the PRE statistics (see chapter 2.3) this corresponds to about 40% of the PRE membership's production.

6.2 Data averaging

Averages have been calculated using a weighted average (product average calculated based on the total energy consumption for the total reference flow).

The carbon footprint for a certain product group was calculated using a vertical averaging. This means that the total product carbon footprint was calculated for each plant and the resulting values averaged across the total of contributing sites.

Where standard deviations were calculated as part of the quality check and data analysis, a non-average was used (see chapter 6.4).

6.3 Data quality

The results of this first product carbon footprinting exercise are representative in terms of products covered, geographical spread and number of replies. See chapter 6.1 for more details on the representativeness.

Only primary, gate-to-gate data has been provided by the refractory companies as this information is directly available to the companies. The level of accuracy has been provided for each product step (see chapter 5.2).

To ensure that the primary, gate-to-gate data collected from refractory member companies was of the highest quality, the excel questionnaire included a sector specific guidance sheet. The PRE Secretary-General was available to answer any requests, hereby supported by the Carbon Trust consultancy. The PRE expert group held regular meetings, including those with the Carbon Trust, and telephone conferences to discuss any issues.

6.4 Results and analysis

Before calculating the carbon footprint for the different product groups, a calculation was made on the energy intensity as based on the 'raw data' provided by the respondents.

The assessment showed a clear differentiation in energy intensity (expressed in MWh per tonne of product packed ready-to-ship) between fired and unfired products as can be seen in figure 4.

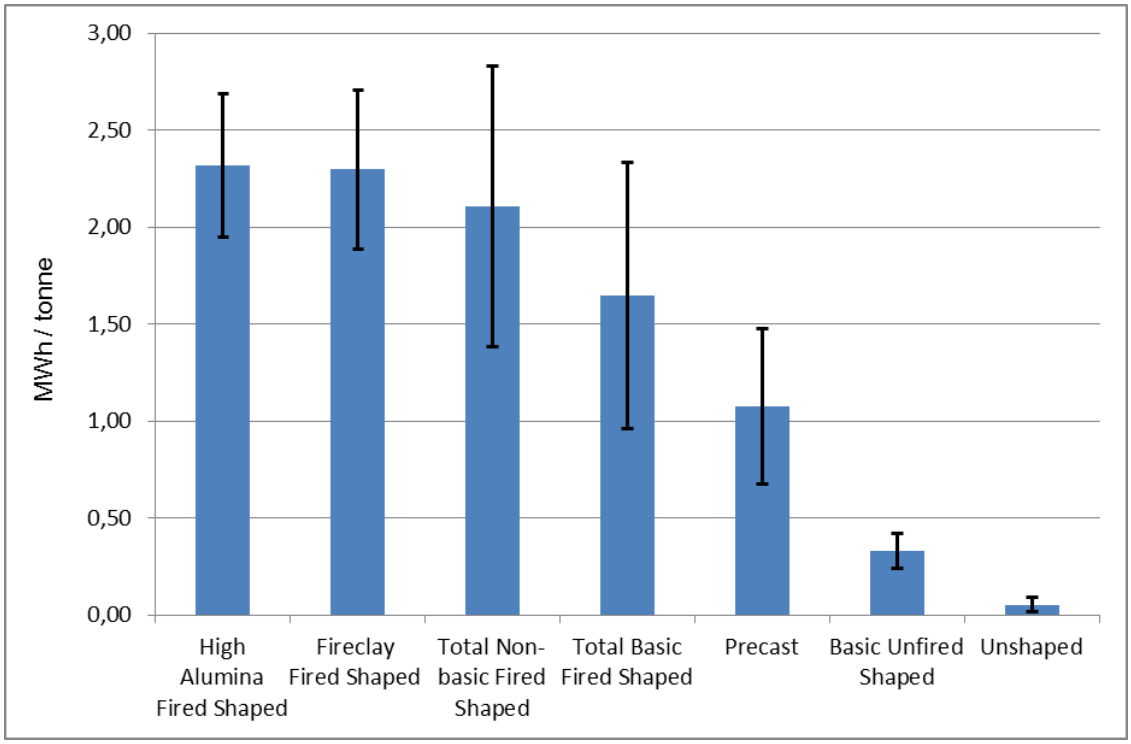


Fig. 5: Energy intensity of different refractory product groups

Further analysis was carried out to understand the spread in replies which lead to following conclusions:

- The spread in energy intensity for a given product group does not relate to a geographical location or size of the company.
- The main contributing factor for differences in energy intensity is the kiln load whereby a high kiln load (standard product, constant temperature, high volume) will result in a lower energy intensity and a low kiln load (special product, complex programme, specific (limited) demand) will result in a higher energy intensity within the same product group.
- Another reason for higher energy intensities are additional environmental requirements such as the post process-combustion of the waste gas, which could contribute to circa 30% of the energy consumption.

The product carbon footprint has been calculated for five different product groups. For three product groups (non-basic unfired shaped, iso-pressed and hydrocarbon impregnated) data were received from too few separate companies to allow for publication. See chapter 5.3 for more details on the confidentiality rules.

The product carbon footprint follows the same tendencies as the energy intensity for the different product groups. The following product carbon footprints have been calculated, as shown in figure below:

Total non-basic fired shaped: **0,606 tonne CO_2e / tonne of product**

Total basic fired shaped: **0,478 tonne CO_2e / tonne of product**

Pre-cast: **0,272 tonneCO_2e/ tonne of product**

Basic unfired shaped: **0,133 tonneCO_2e / tonne of product**

Unshaped: **0,017 tonne CO_2e / tonne of product**

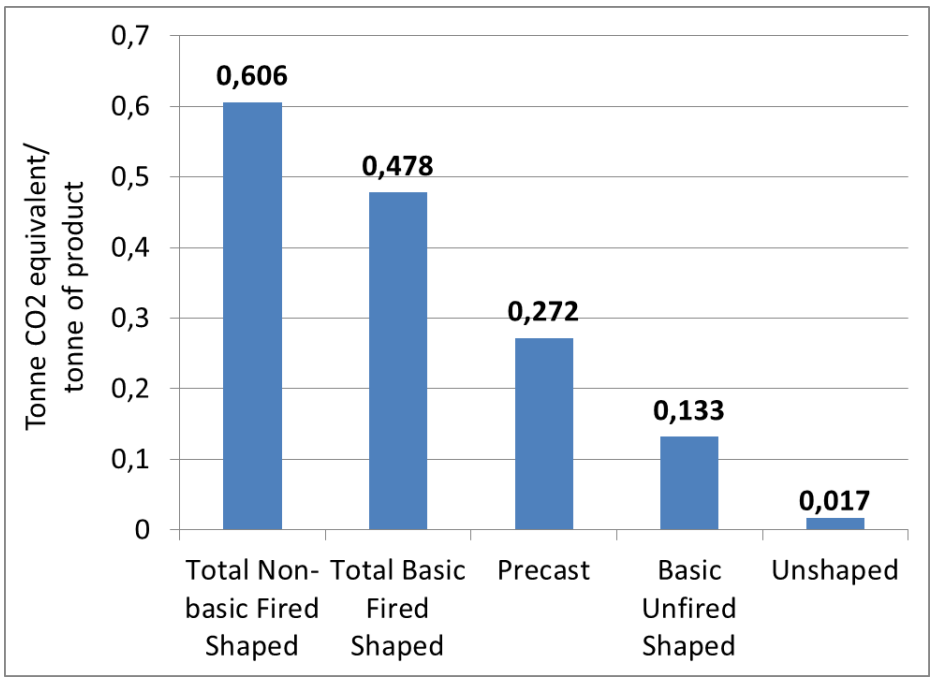


Fig. 6: Product carbon footprint of different refractory product groups

No sites have reported the use of CHP neither the use of CCS or other techniques which lead to the removal of GHGs. No sites have reported specifically on the use of CO2 neutral fuel sources (such as renewable energy).

7. Conclusion and recommendations

The outcome of this first exercise is very positive. Data has been collected from 40 individual sites, representing over 40% of the total annual turnover represented by the PRE membership.

The results documented in this report show that the product carbon footprint shows a direct correlation with the energy intensity, which in turn is mainly depended on the kiln load.

At the same time, the exercise also demonstrated the significant impact of environmental requirements, such as mandatory post process combustion of waste gas, which could increase the energy intensity by up to 30%.

One of the aims of future reporting will be to enlarge the number of product groups for which the product carbon footprint can be reported. In this first exercise, a number of product groups were not yet included in this exercise e.g. the high temperature insulation wools. For other product groups, an insufficient number of replies were received, preventing the calculation of the product carbon footprint.

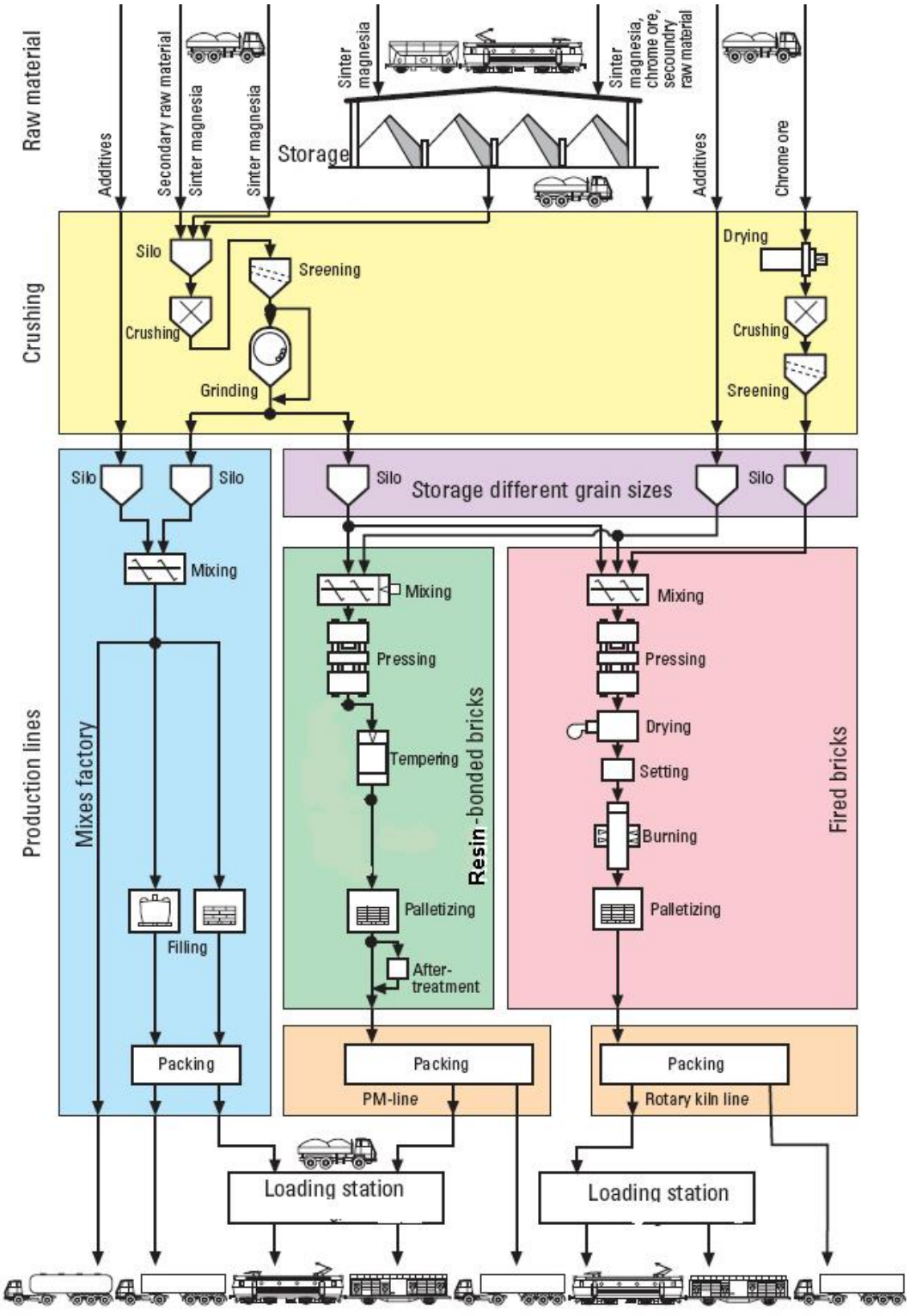
In addition, the use of national conversion factors instead of European conversion factors could be envisaged.

The European refractory industry is committed to continuing this exercise in the future so that over time, possible trends can be made visible.

PRE appreciate the support of the Carbon Trust in carrying out this important exercise, in particular their expertise and assistance in defining the methodology and in reviewing this report.

8. Annexes

Annex I: Refractory process map



Annex II: Example of data collection questionnaire

Reporting period:	Start		End		(please specify both month and year)

Specific questions	reply YES or NO
Do you allow that PRE reports on your data in case less than 3 *companies* report within one product group or its subdivision? (In any case, PRE will not report any data if less than 3 *manufacturing locations* have reported.)	
Does your manufacturing location make use of CHP (combined-heat-power)?	
Does your manufacturing location contribute to the removal of GHG emissions (e.g. carbon capture and storage)? If yes, please specify:	

	crushing - screening		**weighing - batching**		**mixing**	
	value MWh	source of info and additional remarks (e. g. upstream)	value MWh	source of info and additional remarks	value MWh	source of info and additional remarks
Reporting example						
natural gas	7	C	3	C		
electricity	40	M	17	M	20	M
electricity from carbon neutral sources (e.g. renewables)						
diesel						
LPG						
heavy oil	10	M (based on standard conversion factor)	4	M (based on standard conversion factor)		

shaping		**thermal processing (drying, firing, curing, ….)**		**finishing**		**packaging (palletizing, packing, loading)**	
value MWh	source of info and additional remarks	value MWh	source of info and additional remarks	value MWh	source of info and additional remarks	value MWh	source of info and additional remarks
5,2	M	1806	M			4	M
38	M	62	M	2	M	2	M
		30	C				

other (e.g. lighting and ventilation of the production facility)		**description of what was included in 'other'**	**TOTAL**	**CO2 process emissions (e.g. binders)**		**Reference flow (products packed ready-to-ship)**
value MWh	source of info and additional remarks		value MWh	value tonne of CO2	source of info and additional remarks (including source of organic carbon)	value metric tonnes
				0,03	S (source: binder, biog	939
			1825			
2	E	lighting production facility	143			
22	M	internal transport (forklift)				
10	M	internal transport (forklift)				
3	M (based on standard conversion factor)	ventilation production facility	3			

Annex III: Energy conversion factors

Diesel - net kWh by mass	12018,78	kWh/t
Diesel - net kWh by volume	10,02	kWh/l
Fuel oil - net kWh by mass - EU	11515,42	kWh/t
Gas oil - net kWh by mass	12018,69	kWh/t
Gas oil - net kWh by volume	10,41	kWh/l
Kerosene / burning oil / aviation turbine fuel - net kWh by mass - EU	12190,85	kWh/t
Kerosene / burning oil / aviation turbine fuel - net kWh by volume - EU	9,78	kWh/l
Natural gas - low pressure - net kWh by volume - UK	9,89	kWh/Nm3
Petroleum coke - net kWh by mass	9428,83	kWh/t
Coal - net kWh by mass	7098,70	kWh/t

Data provided by Carbon Trust, using the Footprint Expert™ tool 4.1 (2012).

Annex IV: Fuel conversion factors

Natural gas:	0,2600	tonne CO_2 equivalent per MWh
Electricity:	0,4800	tonne CO_2 equivalent per MWh
Diesel:	0,3188	tonne CO_2 equivalent per MWh
Fuel oil:	0,3326	tonne CO_2 equivalent per MWh
LPG:	0,2588	tonne CO_2 equivalent per MWh

Data provided by Carbon Trust, using the Footprint Expert™ tool 4.1 (2012).

Annex V: Communication from Carbon Trust

CARBON TRUST

27 September 2013

PRE Refractory Carbon Footprint Review

The Carbon Trust was pleased to provide support to PRE during the development of their product footprinting methodology and carry out a critical review of the results. The refractories industry has taken an important first step in publicly reporting the carbon impact of their products.

While the methodological approach and report have been based on the requirements of the GHG Protocol Product Standard, PRE chose to limit the scope to the activities directly controlled by its members. The result is a gate-to-gate footprint, which excludes the embodied emissions of the input materials, as well as downstream impacts of distribution, use and disposal. Should downstream users wish to include the impact of refractories in their own product assessments, the figures presented in the PRE footprinting report should be augmented with appropriate emission factors for the material input to form a cradle-to-gate footprint.

The substantive sample size of primary data submitted by PRE's members gives strong confidence in the results obtained being representative of European refractory products. The product groups defined for reporting purposes were chosen appropriately based on the assessment of key underlying characteristics.

The Carbon Trust particularly welcomes PRE's commitment to repeat the exercise in the future, with a number of targeted improvements. Companies involved in this exercise have the opportunity to use the findings to identify hotspots in their processes and investigate reduction opportunities.

The critical review carried out by the Carbon Trust confirms that the methods used to carry out the product inventories are scientifically correct and based on appropriate data. The report clearly states the boundary choice of a gate-to-gate assessment, which makes it inconsistent with the requirements of the GHG Protocol. Nevertheless, provided this choice of scope is always highlighted, the Carbon Trust deems the results to be suitable for public communication.

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