EEB main submission point for the item: 'GHG Emissions / Decarbonisation from Ceramics Manufacturing' under the CER BRER Review

02/12/2019

EEB Suggestion :

- **List GHG emissions to air as Key Environmental Issue (KEI)**
- **Collect information on techniques that either specifically aim to reduce GHG emissions or as a co-benefit**
- **Update information on techniques and sections of the BREF that already mention techniques and information about GHG emission reductions e.g. energy sections.**
- **To consider the collection of information [on the above items] as KEI, even if applied at pilot scale, with the aim to derive BAT Conclusions.**

For more specific suggestions refer to the Initial Position submitted

Contact: Christian.Schaible@eeb.org

2.1 General background on GHG from Ceramics Manufacturing:

In response to the threat of climate change, in 2015, 195 countries signed the historic Paris Agreement within the United Nations Framework Convention on Climate Change. The Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. It includes the goal of keeping the global mean temperature rise to well below two degrees, whilst pursuing efforts to limit temperatures rises to less than 1.5 degrees. Additionally, the Agreement enshrines a goal of net zero greenhouse gas emissions in the second half of this century. Those existing commitments, the upcoming European Green Deal and EU Climate law – under the new European Commission and Parliamentary term (2019-2024) as well as the Zero Pollution ambition will as well focus on climate ambition. For the moment, with the deadline for the EU 20-20-20 climate and energy targets approaching fast, it is noted that while the market deployment of renewable energy is on track in the EU, progress is slower than expected especially with regard to the energy consumption reduction goal.

According to CERAMIE-UNIE[1], ceramics manufacturing the largest emission source is linked to fuel consumption (natural gas) 85% and the remaining 15% running on electricity [it is not clear if those installations run at 100% electricity or not].

1000 ceramics installations "are covered" under the EU ETS. However the Commission Delegated Decision (EU) 2019/708 of 15 February 2019 includes certain ceramic manufacturing subsectors among those at "risk of carbon leakage" for the period 2021 to 2030. The ceramic manufacturing subsectors listed are refractories, ceramic tiles and flags, ceramic household and ornamental articles, bricks, tiles and construction products. **All these subsectors receive free ETS emission allowances up to the level of the ETS benchmarks (set at the level of 10% best performers) and based on historic activity level. It is important to note the ETS benchmarks are not setting a technical standard or performance requirement since installations covered by the EU ETS are allowed to emit above the benchmark**.

Under the EU ETS in 2018 **the ceramics sector had 88% of its greenhouse gas emissions covered by free emission allowances (source EUTL, 2019). This important policy gap has not been well reported in section 3.2.4.3 of the background paper, referring to the EU ETS.**

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[1] Cerame Unie "paving the way to 2050 : the ceramic industry roadmap"

In 2010 the CO_2 emissions from this sector amounted to 19 Million tonnes of CO_2. Those emissions have remained stable since then, at least for the 6 past years[2]. The 2017 GHG amounted to 15,671 kT of CO2eq (source EUTL, 2017).

	2013	2014	2015	2016	2017	2018
Ceramics	15	15	15	15	16	16

The main source of CO_2 emissions relate to the use of fossil fuels for combustion, about 57 % from firing step with another 26% occuring during the drying and treatment process step. Tiles production correspond to the majority of output products of the ceramics industry. Ceramics produce the equivalent of 0.29 tons of CO_2 per ton of ceramic produced[3].
NOTE: this does not include the associated upstream emissions for the raw materials occurring during calcining and the production of magnesium oxide.

According to UK study kilns and dryers are a crucial focus for new energy efficient technologies in bricks manufacturing. However, the power consumption of other processes adds up to over 100,000 tonnes of CO_2 – so potential reductions through best practice and innovations are also an important consideration. A process of consultation led by the British Ceramic Confederation and involving 20 manufacturers, equipment suppliers and research organisations led to the selection of six technologies which have been recommended for further development.

The EU trade federation mentions that 78% GHG emission reductions would be achieved by converting 50% to electric kilns and the remainder to run on syngas or biogas co-fired with natural gas, this looks impressive but is not sufficient according to CERAME-UNIE for reaching their own commitments by 2050[4].

Commitments to act within the CER BREF framework:
The High Level Group on Energy Intensive Industries, of which Ceramics Manufacturing is part of, committed in the Industry written and supported 'Masterplan for a competitive transformation of EU Energy Intensive Industries enabling a climate neutral, circular economy by 2050'[5] the following:

- **The EU energy intensive industries commit to enable a climate neutral, circular economy by 2050**
- **EII industry associations will give strong support to the development of policies to enable the transition to a climate-neutral economy by 2050, whilst keeping industry competitive.**
- **Under the section "deployment of innovative solutions" , the Masterplan states the following:** ***"The Industrial Emissions Directive permitting process should be adapted to support GHG abatement***

[2] Ibid, graphs on page 16
[3] Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Ceramic sector, March 2015
[4] Ibid, page 17
[5] https://ec.europa.eu/docsroom/documents/38403/attachments/1/translations/en/renditions/native

measures in energy intensive installations throughout the transition. The low carbon emission technologies under development should be assessed as potential emerging techniques during the BREF drawing and reviewing process" **(own emphasis added, see page 34)**

Those commitments are also stated in the above cited CERAME-UNIE paving the way to 2050 study.

We expect the industry will stick to its commitment as well at the upcoming KoM and to welcome and information exchange on "low carbon emission technologies" under this CER BREF review. We are aware that this will not necessarily lead to binding BAT-Conclusions or just an identification of "emerging techniques".

2.2. BAT for GHG emission reductions for the ceramics production

2.2.1 General remarks

The prevention / reduction of GHG emissions can be achieved through various techniques:

1. **Alternative energy generation:** e.g. either low carbon fuels, such as biomethane/ biogas displacing natural gas or electrification of heat generation or fuel cells;
2. **Energy Efficiency or process optimisations (including raw materials)**, leading to a reduction of GHG emissions or other emissions
3. **Circular economy techniques:** methods to recycle and reuse Ceramics, aiming to reduce the associated environmental impacts from manufacturing process
4. **Carbon capture / Oxyfuel** which allow the continuation of current manufacturing processes, but capture released gases from the process.

The EIPPCB has already made a good research and listed many relevant projects on possible BAT in the section 5c of the IP draft. All these techniques / projects merit further investigation.

2.2.2. Overview on techniques applied / applicable to the CER sector:

1. **Energy generation**
    a. **Fuel choice (renewable gas when combustion)**

The majority of fuels used in EU ceramics plants is natural gas. The carbon footprint associated with extraction and combustion of natural gas can be reduced by switching to biogas / biomethane, or syngas. As suggested by the industry.

Technique: **switching from use of natural gas to low carbon gas like biogas or biomethane/ or recovered syngas.**

Most relevant process steps: firing, drying and treatment step.

Achieved benefits: The upstream emission (NMVOCs) as well as CO_2 emissions are reduced. Positive net impact if using captured biomethane from agriculture/sewage. Firing and drying processes consume 73% of the total energy requirement of the manufacturing of ceramics

Cross-media impacts: Other air pollutants e.g. NMVOC, formaldehyde and NOx emissions remain

Applicability restrictions: No capital costs would be incurred by switching to biomethane as the fuel. The technology is already used in other sectors (including the gas grid itself) and hence is ready for use by the ceramic industry. Requires gas burners

Cost/benefits: EU-ETS EUA cost saving in same order (73%) for operator. Piera Ecoceramica (Spain) reports annual savings of 566K€ with investment of 676K€, the return on investment was 1,2 years only

Reference plants : Piera Ecoceramica (ES), landfill (biogas),

Sources: http://www.pieraecoceramica.com/produccion-ecologica-con-biogas/

b. Electrification (fuel cell/ electrification of furnaces)

Technique: **Electrification of the firing furnace**
Most relevant process steps: firing, drying and treatment step.
Achieved benefits: The upstream emission (NMVOCs) as well as CO_2 emissions are reduced. Positive net impact if using 100% non combustion renewable energy (0 emissions)
Cross-media impacts: depending on electricity origin (0 if non combustion renewable energy)
Applicability restrictions: ??
Cost/benefits: XXX Hybrid Kiln (Hybrid ring tunnel kiln with flue-gas-based combined heating system as example given with payback period of 2-3 years
Reference plants: XXX
source of information: XXX (used for drying step) Schaffer C. (2015) Hybrid-ring tunnel kiln flue-gas combined heating system: 65% savings on energy – a concept study. Ziegelindustrie International
www.spire2030.eu/dream

Technique: **Infrared radiation**
Most relevant process steps: drying
Achieved benefits: Up to 50% energy consumption reduction
Cross-media impacts: n/a
Applicability restrictions: Limitations due to thickness of end product
Cost/benefits: xxx
Reference plants: XXX
source of information: ICF/Fraunhofer study (BATIS)

Technique: **Microwave radiation**
Most relevant process steps: drying
Achieved benefits: Up to 50% energy consumption reduction
Cross-media impacts: n/a
Applicability restrictions: Limitations due to thickness of end product
Cost/benefit: xxx
Reference plants: XXX
source of information: ICF/Fraunhofer study (BATIS)

Technique: **Fuel cell / Oxyfuel combustion**
Most relevant process steps: firing process
Achieved benefits: Oxy-fuel combustion system separates oxygen and nitrogen from the air, and feeds only oxygen into the combustion chamber. The resulting gases from combustion are then trapped and stored. Could deliver 79% CO_2 emissions savings
Cross-media impacts: n/a
Applicability restrictions: High TRL (5-8)
Cost/benefits: high costs
Reference plants: XXX
source of information: ICF/Fraunhofer study, part I (BATIS)

2. Energy Efficiency and other process optimisations

Technique**: Use of low thermal mass materials / selection of low emissions clays**
Most relevant process steps: ceramics and bricks making
Achieved benefits: Low thermal mass materials and ceramic fibres have reduced energy consumption by using new ceramic formulas requiring less heat during the firing process (up to 20% of energy savings)
Bricks: low emissions clays combined with thermal recovery reduced CO_2 emissions per brick by over 50% compared to previous production method

Cross-media impacts: n/a
Applicability restrictions:
Cost/benefit: xxx
Reference plants: Chesterton Factory (UK) for bricks.
source of information:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651229/ceramics-decarbonisation-action-plan.pdf (p. 48)

Technique: **Improved materials recovery**
Most relevant process steps: all processes
Achieved benefits: depends on process emissions. Material recovery such as sludge recycling, re-use from other industries, unmixed raw material feedback and broken ware feedback, allow for energy savings as they reduce the requirements for raw material preparation.
Cross-media impacts: n/a
Applicability restrictions: Most of the manufacturing process of the recycled ceramic is the same as conventional ceramics. This implies that the cost to setup this technology is minimal. Although there are manufacturers using recycled material, these are still very few.
Cost/benefit: XXX
Reference plants: XXX
source of information: XXX

Technique: **Waste heat recovery**
Most relevant process steps: firing process (this can be pre-heat of bricks during earlier stages of firing, heat recovery to the dryer and pre-heating burner combustion air (rather than ambient temperature air) combined with temperature control system.
Achieved benefits: This process accounts for 57% of total energy consumption, radiant and convective losses can be reduced by up to 60%, reduction of up to 17% energy use (2,664kT CO_2eq if natural gas as reference)
Bricks: low emissions clays combined with thermal recovery reduced CO_2 emissions per brick by over 50% compared to previous production method.
Applicability restrictions: none.
Cost/benefit: 400K GBP for UK industry 25,000k CO_2 savings, payback period estimated between 2-5 years
Reference plants: XXX (Italian Ceramic plants are mentioned)
Source of information: Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Ceramic sector, March 2015 and **Industrial Energy Efficiency Accelerator, Guide to the brick sector, Carbon Trust, UK ;**
https://www.etekina.eu/thermal-recovery/ refers to Italian Ceramic plants,
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651229/ceramics-decarbonisation-action-plan.pdf or http://dry-f.eu/About

Technique: **optimization of pulse burners**
Most relevant process steps: firing process
Achieved benefits: Typically, these technologies can allow for a 10% reduction in drying costs. These are more efficient as the energy can be directed to the ceramic pieces, minimizing waste heat to environment.
Applicability restrictions: none.
Cost/benefit: XXX
Reference plants: Ibstock and Chesterton (UK) brick factories
source of information: Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Ceramic sector, March 2015.

Technique: **Integration of firing kiln design for drying**
Most relevant process steps: firing process/drying
Achieved benefits: XXXX
Applicability restrictions: none.
Cost/benefit: XXX
Reference plants: XXX
source of information: Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Ceramic sector, March 2015

Technique: **Vacuum drying**
Most relevant process steps: drying
Achieved benefits: For ceramics, vacuum could be combined with microwave or infrared (IR) for accelerated and more energy efficient drying. The technology is an optimisation of the drying process which consumes 26% of the total energy cost of manufacturing
Applicability restrictions: used for many years in other sectors, it has yet to become standard in the ceramics industry. So far, reusing waste heat from the firing kiln or IR/microwave technology has been more economical than vacuum drying. TRL to be at 6-7. Vacuum drying kilns would still require an IR or microwave installation and would not be able to use waste heat from the firing kiln
Cost/benefit: XXX
Reference plants: XXX
source of information: Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Ceramic sector, March 2015

Technique: **cold sintering process (CSP)**
Combined heat, pressure and water to lower temperatures to less than 300°C.
Most relevant process steps: firing
Achieved benefits: CO_2 reduction
Applicability restrictions: none.
Cost/benefit: on costs see Table 3-5 on energy savings of cold sintering v. other sintering techniques
Reference plants: XXX
source of information: Decarbonising ceramic manufacturing: A techno-economic analysis of energy efficient sintering technologies in the functional materials sector, Journal of the European Ceramic Society, Vol 39, Issue 16 December 2019
https://www.sciencedirect.com/science/article/pii/S0955221919305527?via%3Dihub

The above listed techniques and progress within the sector, even at pilot scale should be included in the information exchange, with the aim to derive BAT Conclusions.