IED Transformation Plans – call for evidence

17/03/2025

General comments:

The EEB, as well as other civil society organisations involved in co-decision, have been supportive of a forward-looking approach in relation to BAT determination so to identify the most effective options that work in an integrated approach on all various protection goals. The backwards looking approach on BAT determination is a key bottleneck of "innovation" as well as delivery of the zero-pollution ambition, uptake of future-proof BATs[1].

One of the main added values of the IED review (IED 2.0) was to finally integrate climate protection as a clear BAT conditionality and to strengthen the human health protection goal[2].

As it stands, the one and only remaining forward looking and integrated approach aligned provision is the "(deep) transformation" installation level Transformation Plans (Art. 27f) which cross-links to "deep industrial transformation" Art. 3(9a), which asks at least a fraction of the EU operators of IED activities to make an intellectual effort as to how the transformation to "clean, circular and climate neutral "including deep industrial transformation" could concretely look like.

The compromises reached at co-decision phase came to the detriment of significant concessions as to industry (impact) and member states ("admin burden") concerns on several aspects, weakening significantly the initial COM proposal on many key aspects:

a) the time window for real action is extremely generous (2030-2050), only a fraction of IED activities (operators) are required to elaborate on their sustainability plans, but those are the most pollution intensive sectors, hence it is proportionate as to the negative impact burden (as per triple planetary crisis) many of those same operators have actually caused;

b) the measures or plans set out are not legally binding but "indicative", there are no concrete milestones nor Key Performance Indicators (KPIs) so any operator can decide freely as to what they consider "clean" or "circular". This is where we expect clear guidance by the European Commission. We welcome the questions posed / implicit suggestions going in the right direction;

c) Member States Competent Authorities (MSCA) have no role nor involvement whatsoever (despite a responsibility to set the course of the transformation travel for their industries and formal adoption of the delegated acts). First, the task of writing up the plan is on the operator(s), secondly, verification is delegated to environmental verifiers doing anyways compliance checks on Environmental Management Systems already in place.

   The "admin burden" is hence 0 on Member States (besides possible elaborating of a FAQ for operators asking what to do exactly and providing a list of accredited environmental verifiers). This should not be too much effort asked for Member States hosting those activities. Assuming Member States intend to comply with relevant EU environmental protection acquis and the Climate Protection goals, we must assume that the competent

[1] See https://eipie.eu/wp-content/uploads/2022/07/IED-briefing_innovation_v01_15July2022.pdf and https://eipie.eu/wp-content/uploads/2022/07/IED-briefing_zeropollution_v01_15July2022.pdf

[2] See this EEB briefing highlighting the main pros/cons and opportunities of the IED 2.0 / IEP-R https://eeb.org/library/revised-industrial-emissions-directive-and-regulation-establishing-the-industrial-emissions-portal-outcomes-and-opportunities/

authorities or at least the governments would also be equally interested to find out what exactly the operators -they are in charge of (in terms of responsibilities of enforcement)- are planning to do and how that compares in ambition to their industry peers in other EU countries;

d) Where two or more installations are under the control of the same operator, or if the installations are under the control of different operators that are part of the same company, in the same Member States, these installations may be covered by one transformation plan only. This gives a considerable workload reduction for operators to draft up a comprehensive but single plan relating to all installations they are in charge of. However, transformation information shall remain installation-specific and not at company level so it becomes meaningful to the IED BAT determination process, which is always at the industrial activity / installations level;

e) Operators may even influence the qualification of what is considered a "deep industrial transformation", which will give 4 years extra time to the operator to comply. Hence there is a strong self-interest for operators to define the nature of what they think "deep industrial transformation" could mean for their installations;

f) many trade associations (if not all) covered by Art 27b have already done the exercise (Roadmaps, transition pathways, transition plants etc) at least on the climate protection part (see answers below).

This is also why industry trade associations have supported this provision in co-decision, we would not expect a sudden 180° U-turn on their due diligence engagements. Whilst the German chemical industry association (VCI) have been complaining around EMS related point throughout, the President of the EU trade association of CEFIC states that *"Our industry faces monumental expectations from every corner: from investor, consumers, regulators, and civil society. To ride this wave, chemical companies and the sector at large need to implement robust transformation plans"*[3]

With the current admin burden simplification hysteria (revival) at highest political levels within the European Commission and some key Member States, of which we regard the Omnibus I as an aggressive trojan horse of deregulation[4], we appeal on DG ENV to stick to the job mission of the IED 2.0 and respect the integrity of the decision-making progress (no backtracking). BusinessEurope was already successful in emptying the substance of the Climate Neutrality Plans within the CSDDD (Art 22(1), which remain at company level and hence would be of no added value to the IED 2.0 implementation. The double-regulation mantra is often factually wrong and presenting a one-sided perception of the laggards within a certain sector wishing to maintain business as usual, which is at odds with the IED objectives and BAT determination which is dynamic and promotes continuous improvements (See IED 2.0 Art. 1, as amended).

The real added value of the information sharing exercise now entirely depends on the European Commission, when minimal content and format will be defined in the upcoming delegated act. Whilst actual compliance to the plans remains "indicative", the intellectual exercise is very necessary for frontloading to EU BREFs and also -to what we believe should be- the job mission of INCITE to draw (in particular BAT) conclusions from this information provided.

As the IED 2.0 states, the COM shall "specify the content" for the transformation plans (herewith 'TP'), "on the basis of the information required under paragraphs 1, 2 and 3". Paragraphs 1 and 2 is clearly requiring details on the "how?" to achieve "what?" (clean, circular, carbon neutral production). Considering the cross link to the deep industrial transformation, the COM shall explicitly mandate

[3] See Forward of "The Carbon Managers" report cited later in this paper.

[4] https://eeb.org/omnibus-a-trojan-horse-for-aggressive-deregulation-say-ngos/

minimal expectations of any TP to give satisfactory answers on the how's to achieve what by when, this should include the following:

1) details of measures with indication of environmental and climate performance on the various key performance indicators relating to "clean" and "circular". The BAT criteria set in Annex III of the IED already provide clear expectations and the current BAT should be known to the operators as the minimal performance baseline. In relation to climate, the format set under the EU ETS climate -neutrality plans[5] could be used, so to ensure consistency as to minimal expectations for all operators (level playing field) and to enable comparability. Operators that provided already information through that means can simply cross link to those climate transition plans (unless information provided is outdated);
2) specifying the information that is of added value to the IED objectives such as cross-media impacts, technical applicability of transformative techniques and scale of deploy-ability, resource efficiency related optimisation potential etc. The cross-media impacts considerations are a unique feature of the IED BAT determination process, they are relevant if certain decarbonisation techniques may generate negative trade-offs that need to be considered and mitigated;
3) cost and benefits information on the pathways explored, investment needs information and origin of funding (private or public);
4) Other information needed for INCITE to conclude on whether some technique options in the planning qualify as "deep industrial transformative" techniques;
5) Monitoring and progress tracking tools as well as requirements to improve useability of the information i.e. mandatory reporting through the EEA Industrial Emissions Portal.

We believe that in this case the exercise will not be perceived as a "burden" by the operators, considering that plans made will not be legally binding as to its delivery. At least the wider public, the investment community, and other stakeholders willing to progress on EU standards making (with this we also include frontrunner industry part of the EU BREF TWG community) as transition to clean, circular, climate protection "Made in Europe" will see as to whether the EU industry is actually serious in its "transformation" pledges, how "innovative" or "sustainable" as claimed they actually are … or whether this is just a collection of nice intentions/ideas (greenwash) announcements not meant serious as to real actions on the ground. In that case this would equal to a complete failure of the IED 2.0 to provide for a transformation impulse for the EU industrial activities.

In the worst case scenario, all depends on the ambition and clarity provided through the upcoming delegated acts as per paragraph 5 of Art 27 (d), it will at least provide a meaningful contribution to EU BREF frontloading and identification of deep industrial transformation. Here we expect INCITE to take a pro-active role building on the information provided through the TPs.

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[5] As per Commission Implementing Decision 2023/2441 of 31/10/2023

1. **Questions related to the investment gap for the transformation of the installations covered by the IED 2.0 towards a clean, circular and climate neutral industry**

- **Q1: Define transformation pathways for one or more industrial sectors covered by the IED 2.0 to meet decarbonisation, depollution and circularity goals up to 2050, and describe the key underlying technologies and techniques which will drive the transformation;**

See cross-cutting points that should be integral part of each industrial sector in Answer to section II below. In our view all the pathways need to be fit for the wider zero pollution ambition so to reflect the integrated approach of the IED to deliver on all protection objectives equally i.e. high level of environmental protection as a whole, climate protection and high human health protection level.

1. **Cross-cutting to energy intensive industries**

On the needs and the economic advantages to ramp up circularity:

- Material Economics (2018), The Circular Economy a Powerful Force for Climate Mitigation Transformative innovation for prosperous and low-carbon industry.
- Material Economics (2019), Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry
- Material Economics (2019), Preserving value in EU industrial materials: A value perspective on the use of steel, plastics, and aluminium use of steel, plastics, and aluminium.

On the electrification potential of several energy-intensive sectors (iron&steel, chemicals and petrochemicals, non-ferrous metals, glass, cement, non-metallic minerals, paper, etc.)

- Fraunhofer ISI et al (2024): "Direct electrification of industrial process heat. An assessment of technologies, potentials and future prospects for the EU".
- Hasanbeigi, A., Springer, C., Sibal, A. 2024. "Electrifying European Industry - Part 1: Electrification of Industrial Processes. Global Efficiency Intelligence." Florida, United States. Part 2 relates to Electric Boilers and Steam Generating Heat Pumps.
- Rosenow, J., Oxenaar, S., & Pusceddu, E. (2024). "Some like it hot: Moving industrial electrification from potential to practice." Regulatory Assistance Project.

The LeadIT Group (Stockholm Environment Institute) provides a useful overview on the various transition roadmaps on various IED sectors, however it is limited to climate protection objectives only: https://www.industrytransition.org/. However, it provides many of the transition pathways only in relation to decarbonisation (and as put forward by countries or companies).

2. **Iron and Steel production:**

On technologies able to decarbonise iron ore-based production:

- Agora Industry, Wuppertal Institute and Lund University (2024): "Low-carbon technologies for the global steel transformation. A guide to the most effective ways to cut emissions in steelmaking".
- Agora Industry and Wuppertal Institute (2023): "15 insights on the global steel transformation".

From the perspective of the EEB we see the following 3 routes for iron and steel production as BAT of which 2 are iron ore based:

1. **Scrap based – Electric Arc Furnace (EAF) route powered by 100% nature positive renewables**

This production route is already recognised as BAT in the I&S BREF but several improvement potentials are available: The 2010 I&S BREF states that the specific energy consumption is in average about 1.8GJ/t liquid steel, with an average fossil fuel input indicated at 0.5GJ/t. We regard these figures as no longer corresponding to BAT, considering that the *use of electricity from fossil free energy sources* is established BAT for related sectors. The EU ETS benchmarks suggest the current GHG intensity to be at 0,215 / 0,266t CO2eq/t (carbon/high alloy steel). We expect further GHG performance improvement potential by a considerable increase of the share of renewable electricity, as well as other air pollutants benefits if this electricity is generated by non-combustion type of renewables.

Further improvements are also expected from the switching to renewables based reducing agents. According to Soler-group, the use of biocarbon combined with biogas could reduce residual GHG emissions to 80kgCO2eq/ t of steel.

Mercury and dust emissions but air emissions of inorganic and organic compounds still remain relevant pollutants with further mitigation potential. The main focus is on input controls for scrap quality and dedicated mercury controls. In order to be rated as "clean", the upstream pollution impacts need to be thoroughly addressed, in particular within the shredders. It is key that the scrap provider implements a rigorous deflagration prevention plan and that dust levels are below 5mg/Nm³, also to prevent particulate bound metals or PCBs to enter into the environment. The depollution goal is particularly relevant for addressing legacy pollution on site of shredder plants.

The level of <5mg/Nm³ (daily average) for primary and secondary dedusting (BAT 88) is regarded as BAT and we suggest to maintain that level, however the level of <10-20mg/Nm³ for on-site slag processing (BAT 90) shall be reconsidered since more effective techniques are available. The 50µg/Nm³ for mercury (BAT 88) should be reconsidered considering available hg specific abatement techniques.

2. **Iron ore based (electrolyser based) H2- DRI-EAF route**

This is the pathway chosen for the EU integrated steel sites operators as well as globally as the most promising. See Lead IT "Green" Steel tracker for more information. Most advanced projects in the EU: STEGRA and SSAB/Hybritt.

3. **Iron ore based Molten Oxide Electrolysis (MOE) route**

See Boston Steel, cost data should be available from the company[6]. The company states that the process is "cost effective" and will enter in commercial operation in 2026.

The process uses renewable electricity to convert all types of iron ore grades to liquid metal through an inert anode immersed in an electrolyte containing iron ore. The MOE cell heats up to 1600C.

The main advantage of this pathway is that all types of iron ore grades can be used. The process does not require process water, hazardous chemicals or catalysts. The liquid metal can be directly used to ladle metallurgy, otherwise reheating will be required (energy loss)

[6] https://www.bostonmetal.com/green-steel-solution/

4. Cement / Concrete Production

On technologies able to decarbonise and depollute cement and concrete production:

- JRC (2023) Decarbonisation options for the cement industry: JRC Publications Repository - Decarbonisation options for the cement industry
- Le processus de fabrication - Ciments Hoffmann Green
- Technology | Brimstone
- Holcim launches Europe's first calcined clay low-carbon cement operation
- (2023) LC3, A sustainable alternative for the cement industry: Vorgaben für Intranet, Vorlage Fachpublikation, Programme geografisch & thematisch 210212
- Alliance for Low Carbon Cement and Concrete (2023) "How can they help tackle cement and concrete's emissions problem?": Factsheet-on-SCMs-in-making-low-carbon-cement-and-concrete-a-reality-October-2023-final.pdf
- Electrification:
    - https://coolbrook.com/electrification-solutions/rdh-industrial-process-heating/
    - First Commercial Electrochemical Cement Manufacturing
    - Dunant, C.F., Joseph, S., Prajapati, R. *et al.* Electric recycling of Portland cement at scale. *Nature* **629**, 1055–1061 (2024). https://doi.org/10.1038/s41586-024-07338-8
- US IRA pre-listed finance projects for cement and concrete
- Mercury emissions:
    - German legislation dated back in 2013 (17. BImSchV) which already provides a level of 30µg/Nm³ (daily average).
    - German UBA study (2021) stating that levels below 10µg/Nm³ are achieved

The global CO2 footprint for Portland cement (CEMI) is 881 kg CO2eq/t, while in the EU, it ranges from 500–800 kg CO2/t[7]. Hoffman Cement, in Bournezeau (France), has reduced emissions to 161 kg CO2eq/t using an alternative clay/activators process (Hoffmann Cement H-IONA), primarily through clinker substitution. Brimstone suggests using carbon-free silicate rocks instead of limestone to deeply decarbonise cement. Holcim and Lafarge have teamed up on projects at the La Malle and Saint Pierre La Cour sites (France), claiming "close to zero" emissions or a 50% GHG reduction (~441 kg CO2eq/t) through kaolin clays, waste heat, and renewable fuels.

Limestone Calcinated Clay Cement (LC3) already achieves a 40% reduction in GHG emissions by substituting clinker with calcined clay (<50% ratio), with 20 plants worldwide producing LC3 cement. Holcim reports plants in Austria and the Czech Republic running on nearly 100% alternative fuels, while their Columbia site operates on 100% renewable energy. The US IRA has pre-listed six projects for cement decarbonisation, including Brimstone Energy (using silicate rocks) and National Cement's biomass-based plant combining LC3 and carbon capture.

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[7] based on CEMBUREAU (2006), figure 1.19 CLM 2013 BREF, requoted by the 2023 JRC report on the Decarbonisation options for the cement industry

The current clinker-based production is being improved through renewable energy, with Holcim reducing emissions through on-site renewable energy generation and 100% renewable energy purchase agreements. Electrification technologies, such as Coolbrook/ABB's RotoDynamicHeater for high-heat kilns, are expected to reduce CO2 emissions, with a commercial launch planned for 2025.

CCUS may be useful for mitigating residual GHG emissions in existing cement plants. Ongoing CCS projects include Heidelberg's Edmonton (US, 2026), Holcim's Richmond (Canada, 2025), and a cryogenic CCS project in Sugar Creek (US, 2025).

From the perspective of the EEB, recognising that clinker is the primary component responsible for almost 90% of the GHG emissions, the transformation plans should define the options available for decarbonisation, depollution and circularity in a prioritised manner to enable the transition. They should therefore be considered in the following order of priority:

- Technologies that aim to substitute clinker with recycled clinker or supplementary cementitious materials with a focus on circularity in recycling cement back into clinker.
- Efficiency measures in existing cement kilns, like alternative fuels and electrification.
- Alternatives to clinker based on new materials like silicates and have net positive GHG emissions.
- Technologies which improve the carbon capture technologies into recreating clinker alternatives.
- Improvements in highly efficient (95%) and permanent carbon capture and storage.

There is also significant air pollutant mitigation potential, considering the techniques and associated emission levels included in the outdated EU BREF for Cement, Lime and Magnesium Oxide production (CLM BREF), and comparing those with the performance that can be achieved by state-of-the-art technologies like Selective Catalytic Reduction (SCR), fabric filters, as well as dedicated mercury emission controls: dust below 5 mg/Nm³, NOx below 200 mg/Nm³, and mercury below 10 µg/Nm³ can be obtained.

5. Chemicals manufacturing

(Industry) Studies/pathways on the topic

- DG GROW transition pathway for the chemical industry (the Annex of this industry roadmap sets out details of various pathways promoted by the chemical industry, with cost information)
- "The carbon managers" (CEFIC).

Note that the report assumes a pathway with still a very high share of fossil-based feedstocks to continue (35%) as an input, putting into question on whether the sector actually wants to become carbon neutral / fossil free one day. The key transition lock-in parameter of the petro-chemical industry is related to its fossil input addiction and conflicting interest to maintain the fossil based (crude/naphta) pathway because the biggest downstream user (client) of refineries (in majority owned by the very same companies) is the petrochemical industry (as the name explicitly suggests).

Effects of substitution of feedstock on sustainability of biomass needs to be carefully balanced out. Annex 5 refers to a biomass requirement amounting to 640Mt (dry matter) on a yearly basis in 2050, which is quite extreme, the credibility on its realisation as to sustainability impacts (biodiversity, land use conflicts) can be questioned.

All the building blocks identified as "critical" come from the Steam Crackers, if which the EU has about 35 in operation. All of those run on fossil feedstock and fossil energy.

In the "Carbon Managers" (CEFIC) report, the baseline scenario assumes little change in output capacity, moving from 21 Mtons ethylene output to about 17Mtons in 2050 (see chart 26). Section 9.2 has details on the Technology pathways, chart 26 indicates that conventional steam crackers will be around even in 2050, with others partially or fully electrified. Feedstock consumption figures are provided in Chart 28, pointing to a high fossil input share. The report assumes a very high fossil feedstock share of 35% (see page 17) in 2050, putting into question if the chemical industry is actually able to transform to a fossil free chemicals production.

However, Olefins can also be produced through alternative routes (bioethanol dehydration/ propane dehydrogenation. Methane pyrolysis is also mentioned by considered as not significantly deployed).

A full overview of the production techniques pathways is provided in Annex II of the report with an indication of commercial availability. Annex III provides very useful information as to assumed cost parameters. Unfortunately, the wider environmental and human health benefits from techniques switching have not been quantified in monetary terms. Negative impacts from the use phase and end of life phase of chemicals is not addressed.

- An electrified cracker is running at pilot scale at the BASF Ludwigshafen site (pilot), 6MWel. See related tech providers info in the internet https://coolbrook.com/electrification-solutions/rdr-electric-cracking/.
- The Ineos ONE project (only commercial stage EU cracker project) in Antwerp is neither transformative nor innovate, considering that it is not electrified, it runs on ethane but is much more efficient due to the catalyst used. It may in future run as well on biomethane and retrofit CCS but this is just a long distance promise.
- An interesting technique transition pathway is to do cracking through kinetic energy instead of steam. https://www.siemens-energy.com/global/en/home/press-releases/siemens-energy-and-technip-energies-announce-joint-development-decarbonized-rotating.html
- BASF also operates an industrial heatpump GIC KARASEK with a 10Mwel scale, allowing to generate low temperature heat (200 C°), the cost issue is electricity prices.

The EEB will soon provide further input in relation to decarbonisation options that are applicable to the inorganic chemicals, within the LVIC BREF review (BATIS) – we can provide the information to the consultants as well, when uploaded.

A group of Member States governments and the Chemical Industry are asking for a "Critical Molecules Act" https://data.consilium.europa.eu/doc/document/ST-6901-2025-INIT/x/pdf This paper also provides interesting insights as to where the transformation focus should take place, in particular its Annex B. First the main techniques pathway for the chemical sector is to get pollution down from the steam crackers, those are the most pollution intensive processes. This transformation is hence highly relevant in the first place for oil and gas refineries, which are servicing the downstream petrochemical industry value chain, often integrated as owned by oil and gas companies running the refineries. The Annex B lists (non-exhaustive) technical options the transformation pathways should focus efforts on. This is about "bio-based" molecules aimed to substitute fossil feedstock:

"• **Bio-based Glycerol and bio-based ethanol**: those are probably the bio-based molecules with the largest volumes produced to date, as they have benefitted from the development of biofuels. The current volumes are large and could be progressively made available for the chemistry sector as combustion engines will gradually phase-out. The technologies are largely available and have a final molecule cost close to their fossil-sourced counterparts.

As many alternative bio-based molecules are currently being investigated and a lot of uncertainty remains as to which ones are the most likely to emerge at scale, a non-exhaustive list of molecules of interest that have been identified by the Member States is provided, according to a few of their advantages. Please note that this is far from a complete overview (both in terms of molecules and advantages):

• **Bio-based molecules with no fossil equivalent**: lactic acid, itaconic acid, glutamic acid, pelargonic acid, azelaic acid, 3-hydroxypropionic acid, hydroxybutyrolactone, sorbitol.

• **Bio-based molecules that are very good platforms (a large number of molecules can be synthetised from them):** furan, furfural, hydroxymethylfurfural (HMF), furandicarboxylic acid (FDCA), fumaric acid, malic acid, levulinic acid, xylitol/ arabitol, biobuthandiol.

• **Bio-based molecules that are often cheaper than their fossil-based counterparts**: acetic acid, succinic acid, propanediol.

Additionally, it should be noted that the biochemistry sector faces multiple challenges in order to scale-up and deliver the volumes necessary to replace (part of) the petrochemical sector. Two of them being the availability of primary materials (2G feedstocks are likely insufficient to deliver large scale volumes, meaning that the debate to dedicate cultures for biochemistry – as has been done for biofuels – may need reopening) and the regulatory constraints before entering."

As highlighted above, the transformation pathway for the petro-chemical and downstream chemical industry should also explain how the sourcing of alternative feedstock can be handled in sustainable ways.

Literature / search in the internet can indicate a lot of innovation relates to plastics, an illustrative example is e.g. https://www.tecnaro.de/en/ (bioplastics processing technologies for industrial use). Other relevant practical applications are based on the "cradle to grave" concept by https://mcdonough.com/cradle-to-cradle/ and https://michaelbraungart.com/cradle-to-cradle/ .

Those forward looking (BAT) for chemicals manufacturing also consider the use and end of life phase of products impacts from a full LCA perspective. The approach is based on the well known '12 Green Chemistry' principles, which are fully aligned to the official EU BAT criteria.

6. Ceramics Manufacturing

On technologies able to decarbonise the ceramic manufacturing industry:

- European Commission (2024). Best Available Techniques (BAT) Reference Document for the Ceramic Manufacturing Industry. Review on-going. First draft: CER_D1_Updated_BW_web-bref.pdf
- British Ceramic Confederation (2023). Hydrogen for the ceramics sector; Industrial fuel switching phase I: British Ceramic Confederation: Hydrogen for the ceramics sector
- Dylan D. Furszyfer Del Rio, Benjamin K. Sovacool, Aoife M. Foley, Steve Griffiths, Morgan Bazilian, Jinsoo Kim, David Rooney (2022). Decarbonizing the ceramics industry: A systematic and critical review of policy options, developments and sociotechnical systems: Decarbonizing the ceramics industry: A systematic and critical review of policy options, developments and sociotechnical systems - ScienceDirect
- UNEP (2021). Sustainable Ceramic Production: A Guide to Decarbonization: UNEP Sustainable Ceramic Production
- European Commission (2020). Decarbonisation of the European Ceramic Industry: Policy Recommendations and Best Practices: European Commission - Decarbonisation of the Ceramic Industry

- CERAME-UNIE (2020). The European Ceramic Industry's Roadmap to 2050: CERAME-UNIE Roadmap to 2050

From the perspective of the EEB, the critical elements of decarbonizing the ceramic sector are: (a) the switch from fossil fuels, primarily natural gas, to renewable energy sources (e.g. hydroelectric, solar, wind, or alternative renewable fuels) for firing and drying processes; and (b) the electrification of drying and firing using electricity from such sources. The use of electric kilns for firing ceramics is already employed in specific sectors like tableware and technical ceramics and is being tested for broader applications (e.g., clay blocks, brick slips). The introduction of hydrogen as a partial or full replacement for conventional fuels in firing processes is also emerging in the sector (see reference above from BCC); as well as microwave-assisted firing techniques. Regarding drying of ware: heat pumps, or microwave-assisted drying technologies powered by clean electricity can further reduce the reliance on fossil fuels and improve energy efficiency in the drying process. Other important techniques are linked to the optimisation of raw materials composition, e.g., substitution of fossil additives (e.g. pore-forming agents) with low-carbon or renewable materials (e.g. paper sludge, sawdust), or use of low-carbonate clays.

The deployment of these technologies will not only enable the decarbonisation of the sector but would also contribute to the fulfilment of the 2050 goal of zero-pollution, since the reduction of fuel-based pollutants, such as particulate matter, is an additional benefit of adopting clean energy solutions. Independent of that, we note improvement potential regarding air pollution abatement, esp. for dust, NOx and SOx as observed from the recent data collection in the context of the review of the EU BREF for ceramics manufacturing and the associated emission levels proposed.

Improvement potential exists also regarding circularity, that extends beyond material use to product design and assembly: design changes are implemented by part of the sector to facilitate recycling and reuse, such as modular assemblies or designing ceramics that do not require mortar.

7. Other IED sectors

See LeadIt Group roadmaps / company websites / findings by INCITE for other sectors.

- **Q2: Assess the costs of sectoral transformation in terms of depollution, decarbonisation and circularity;**

On the costs of different technologies to transform steelmaking:

- Agora Industry, Wuppertal Institute and Lund University (2024): Low-carbon technologies for the global steel transformation. A guide to the most effective ways to cut emissions in steelmaking.

On the costs of the transformation in terms fuel costs, electricity costs and carbon costs (several sectors are included):

- Hasanbeigi, A., Springer, C., Sibal, A. 2024. Electrifying European Industry - Part 1: Electrification of Industrial Processes. Global Efficiency Intelligence. Florida, United States.

State aid decisions as well as decisions taken on IPCEIs can also provide cost information see in relation to hydrogen 'Hy2Tech', 'Hy2Use' etc[8].

Granted EU state aids in relation to iron and steel production are as follows (status March 2024):

MS	Date	Case number	Company	Location	State aid in € billion
DE	23.3.2024	SA.104898	ArcelorMittal	Bremen & Eisenhüttenstadt	1,3
DE	19.12.2023	SA.105337	SHS Stahl-Holding-Saar GmbH & Co KGaA ('SHS')	Völklingen and Dillingen, Saarland	2,6
DE	20.7.2023	SA.105244	ThyssenKrupp	Duisburg	1,45
FR	20.7.2023	SA.104903	ArcelorMittal	Dunkirk	0,85
BE	22.6.2023	SA.104897	ArcelorMittal	Ghent	0,28
DE	17.2.2023	SA.63733	ArcelorMittal	Hamburg	0,55
ES	17.2.2023	SA.104904	ArcelorMittal	Gijon	0,46
DE	4.10.2022	SA.104276	Salzgitter	Lower Saxony	1

EU state aid decisions also provide cost-estimates. This can be searched through the relevant NACE codes of the economic activity in the EU register https://competition-cases.ec.europa.eu/search?caseInstrument=SA

The EU STEP funding portal (STEP Seals Dashboard and Map) https://strategic-technologies.europa.eu/investors_en and related database with projects https://strategic-technologies.europa.eu/get-funding_en gives an overview of funding objects in the pipeline / granted.

- **Q3: Identify relevant funding sources and financing options available to IED 2.0 installations to support implementation of depollution, decarbonization and pro-circular techniques (including any analysis of funding sources accessed to date, and the potential of different sources to contribute going forward);**

On the need to phase out free allocation to increase the ETS revenues forming the Innovation Fund:

- Carbon Market Watch, WWF EU, 2025, A Clean Industrial Revolution in Europe
- Internalisation of negative externalities on pollution could be an easy means to provide funding for the industrial transformation, by putting a cost on pollution that is higher than maintaining business as usual at the expense of human health and the environment. This is a policy option available as a key principle since the 70ies, but so far lacks political courage for implementing it (i.e. the "polluter pays principle"). Considering the current state of the environment the principle should go even beyond, (Polluter prevents and restores principle). The upcoming method for CBA under the IED (Annex II) could be a means to put the benefits of pollution gains in perspective to costs for the operator to produce in a responsible manner.

  See related EEB suggestions on this here (CEEAG) and here (GBER -2021). Suggestions to internalisation of external costs as well as the call for a "Toxic Free and Zero Pollution Ambition Compatibility Check" for any support schemes applied have also been requested

[8] https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis/hydrogen-value-chain_en

by industry frontrunners, part of the informal coalition for an Industrial Blueprint. This compatibility check should be an integral part of conditionality check for the upcoming Competitiveness Fund.

Environmental taxes / levies / fees can be a source of funding clean industrial production techniques and help the reduction of pollution and waste of raw materials and resources. At the EU level, total environment related tax revenue amounted to 2.2% of the EU GDP, while the costs of air pollution and GHG alone are at about 5 % of the EU GDP. This is not very far from the estimates from the Draghi report which states the investment needs for Europe to become decarbonised and competitive is around 750- 800 billion each year or around 4-5 % of EU GDP. The European court of auditors in its 2021 report on the Polluter Pays Principle shares the view that polluters don't often pay the full cost of pollution and European taxpayers too often have to pay instead of polluters.

While GHG costs for some industry may be partially paid via the ETS, most other environmental damages are not internalised as costs and recovery of these costs could offer a potential source of funding for the clean industrial production technologies. This has also been recommended by the European Environmental Agency as a way forward for funding the climate transition. While carbon taxes are often seen as the most efficient and directly related to decarbonisation measures, many climate-friendly technologies are also often less polluting (in particular air pollutants). Thus, the same logic of funding decarbonisation by taxing carbon emissions can be extended to taxes on other environmental pollutants as well.

- **Q4: Explore how the costs of transformation and access to funding may vary by size of business (in particular assessing potential implications for SMEs).**

No comment /opinion on this question.

2. **Questions related to transformation plans**

- **Q5: General objectives: the general objectives should articulate the overarching aims of the transformation plan, aligning with the goals of IED 2.0 and EU policies such as climate neutrality, zero pollution, and a circular economy.**

While we understand the general aim of this first point, we think that **overarching principles** for an industrial transformation in line with the requirement of article 27d of the IED (*…contribution to a sustainable, clean, circular, resource-efficient and climate-neutral economy…*) should be included already at this stage. See "general comments" section.

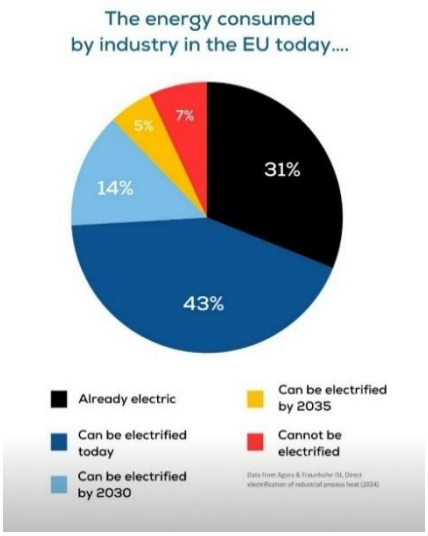
The term "deep industrial transformation" is clearly defined in Art. 3 of the revised IED, as *"the implementation by industrial operators of emerging techniques or best available techniques involving a major change in the design or technology of all or part of an installation or the replacement of an existing installation by a new installation, which allows an extremely substantial reduction of emissions of greenhouse gases in line with the objective of climate neutrality and optimises environmental co-benefits, at least to the levels that can be achieved by techniques identified in the applicable BAT conclusions, taking into account cross-media effects"*. In Article 27e of the revised IED it is also noted that *"the permit for the installation contains (…) the emission levels and the resource efficiency that will be achieved"*.

It is clear that the aim is to deliver on all protection objectives equally i.e. high level of environmental protection as a whole, climate protection and high human health protection level. Such overarching principles should be pursued simultaneously in all transformation plans.

The EEB has suggested in the Transition pathway for Energy intensive Industries (EII) a set of (5) thematic Key Performance indicators (KPIs) which could apply equally to all other IED Activities[9].

Climate protection

- An explicit goal to phase out fossil fuels and, where possible, combustion processes by 2040 at the latest in favour of electrified processes (see figure).
- An explicit goal to reduce GHG emissions by 90% within 2040 and by 100% within 2050.
- An explicit goal to reduce energy demand of energy-intensive industries.



Air Quality:

- An explicit goal to reduce air pollution in line with the requirements of the World Health Organisation[10].
- lowest technical abatement level for Carcinogenic Mutagenic or Reprotox substances.

Water Protection (achieving good quality and chemical status)

- phase out of priority hazardous substances and compliance with the Maximum Allowable Concentration levels (for Priority Substances) prior to any dilution;
- Improved water recycling rates and performance levels for water consumption compared to the specific sector benchmark;
- Phase out of PFAS / detection limit for direct waste water discharge.

Phase out and substitution of chemicals of concern throughout the lifecycle (Toxic Free Environment)

- substitution of SVHC and other substances of concern ahead of REACH deadlines (this is also required by the alternatives assessment for hazardous chemicals under the revised EMS provisions of the IED 2.0). Restriction and use minimisation of substances of concern
- Zero release of hazardous chemicals, including accidental release
- Full implementation of the remediation and restoration principle
- Soil remediation costs are recovered in full by the industry liable of the damage (including mother companies).

Possible indicators could be a *Substitution index (% of substances not meeting the properties of chemical of concern, substitution rate of chemicals for delivering a technical function by non-chemical*

[9] See KPI standalone proposal here https://docs.google.com/document/d/16TEJB8iwc7JvVJtFLy6kWNxIkISUaKS1AdLI7yZmnLY/edit?%20usp=sharing&tab=t.0

[10] https://www.who.int/publications/i/item/9789240034228

alternatives) or a Decontamination index (destruction efficiency of hazardous waste streams, residue level of POP content)

Such overarching principles would allow to prevent a simple finetuning of fossil-based processes for marginal gains in emissions reduction or efficiency, as well as prevent the creation of stranded assets based on fossil-based processes and only allowing the reduction of emissions of a subgroup of harmful substances (e.g. investments to install CCS facilities where fossil-free alternatives are available, etc.)

As overarching principles we suggest to invite the operator to:

- Stick to the general points / minimal expectations as mentioned above (in page 3);
- Provide explicit goals to increase the use of recycled contents in final products and transformation to closed loop production, if feasible. The closed loop / industrial symbiosis considerations may have implications as to the end of waste criteria and should consider a LCA approach as to equivalence/benefits/drawbacks of considering a material a waste, residue, by-product, fuel etc. The overall high protection ambition should be based on factual evidence and the guiding consideration as to relabelling certain resources differently, for the sale of legal clarity viewpoints. More easy/practical indicators could relate to quantitative reduced material use and improved material use efficiency rates (recycled content), based on transparent sector benchmarking performance and indicating minimal share of sustainably sourced renewable feedstock for production consistent with the EU climate goals and cascade of use principles for biomass;
- Provide information on how the operator will restore water / soil (legacy pollution), where relevant (techniques implemented to restore site, affected communities by the industrial activity in question. This information should be available in the baseline report;
- Identify techniques able to speed up the phase out of fossil fuels and harmful chemicals (e.g. product substitution);
- Detail the share of renewable electricity used / produced on site with milestones set to 2035 and 2040 and 2050. The TP should also indicate the amount of RES consumed in relation to total needs / purchased through PPAs, which is also a form of commitment.
- Detail investment plans to make promising “emerging techniques” viable for a wide uptake. E.g. the installation to phase out primary raw materials-based production processes (such as Portland cement or iron-ore based steel) and replace it with secondary raw materials-based processes (e.g. low-clinker or 0-clinker cement or Electric Arc Furnaces to process steel scrap)
- Detail on how to contribute to the emergence of a sustainable economy by 2050 through the facilitation of “enabling conditions” such as, for instance, investments for in-site production and use of renewable energy, energy storage, corporate behaviour in advocacy with a clear commitment to implement the EU Green Deal / Zero Pollution Ambition.

- **Q6: Baseline performance: provides information on emissions and resource consumption for the baseline year under which the plan is produced. This would allow the level of ambition in the specific targets to be appraised and also allows tracking of progress in interim years. Much of this information is likely to be already reported under the IEPR or included within the EMS.**

It is correct that the EMS contain minimal information that needs to be reported on the environmental reports on an annual basis. Yet the benchmark indicators are not yet set at sector level, and the data

extraction is poor since there is a lack of harmonised format for digital reporting at EU level. The EU EMAS register lists the companies and some do provide the environmental reports through the register. The search functions are fit for purpose as to the sectoral / country search but could be extended on the topical sections as per Annex IV of the EMAS Regulation.

Whilst the content of environmental reports is similar (due to the similar structures / content of the EMS because they need to comply with the Annex IV of the EMAS Regulation), they are not harmonised and easy navigating / extraction of the information on performance is not yet possible. The environmental reports are not made available via the EEA-IEP-R, but doing so is a quick win and easy to implement.

The EEB fully supports the digitalisation and harmonisation of the reporting templates at EU level so the access and the usability of this information is improved. The European Commission should explore, together with EU-BRITE and the EEA whether an interactive database could be set up specifically to enhance EMS related reporting on key benchmark indicators "core environmental performance indicators already mentioned in the Annex IV of the EMAS regulation[11], and hence mandatory). This is also needed for the purpose of making the revised EMS provisions of the IED 2.0 operational and will revive attractiveness and added value of EMAS. As a minimum, operators of IED activities should provide a functional URL to the Environmental Report of the EMS (EMAS or ISO 14001) in a digital format so to allow extraction by the EEA to the Industrial Emissions Portal. The EEB fully supports to make the TP (final version) available through the EEA industrial emissions portal on the landing page. A dynamic EMS reporting database, either integrated to the IEP-R Portal or standalone would be welcome so to enable operators to provide up to date information more swiftly.

So far there is no resource input related data reported to the IEP-R nor production volumes, nor other information allowing contextualisation, this is a significant shortcoming from assessing any progress on environmental performance. However, we expect considerable improvements thanks to the revised IEP-R and the use of digital tools.

Normally, we should expect the annual compliance reports as per the IED Art 14(1) point d) to contain the necessary information as to how the operator complies with the requirements in the permit, which should also address resource consumption but also other emissions data. See earlier studies by the EEB in relation to LCPs as a case study, results of good/bad practice are very country to country specific[12].

- **Q7: Specific time-bound targets (quantitative): specific quantitative time-bound targets translate the general objectives into measurable outcomes, providing benchmarks for environmental performance to track progress. These should include targets for greenhouse gas emissions reduction, improvements in energy and resource efficiency, and reductions in specific emissions of pollutants. These elements may be linked to BAT-AELs, BAT-AEPLs and benchmarks (for performance levels), and units and metrics for reporting contextual fields under the Industrial Emissions Portal.**

The EEB fully supports the implicit suggestions in this question. We need common reference points i.e. Key Performance Indicators (KPIs) s so to understand where we start from and where the operator intends to go to on its transformation journey. Such specific targets should be developed against the overarching principles set above (see Q5) notably the overarching KPIs[13] and the general minimal

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009R1221-20230712

[12] https://eeb.org/library/industrial-plants-data-viewer-background-briefing/

[13] https://docs.google.com/document/d/16TEJB8iwc7JvVJtFLy6kWNxIkISUaKS1AdLI7yZmnLY/edit?%20usp=sharing&tab=t.0

requirements such as made in “general comments”. Answers provided under Q5 provide practical suggestions.

The reporting should be done exclusively through a digital format that is harmonised on the key metrics and parameters, so to allow comparability and maximum added value for other information exchanges (e.g. INCITE, EU BREF reviews, identification of deep industrial transformation, needs for support to the industry in terms of costs, scale of public interest benefits for the transformation pathways etc)

It may be helpful to then deep dive for sector relevant KPIs, which would be optional to fill out for other Industrial activities where the indicator is not relevant. E.g. if a given industrial activity does not use water or hazardous chemicals, those thematic parameters would be irrelevant as to potential progress margins and hence no further reporting besides “not used, n/a” would be necessary.

Further sector / technique options specific points

- When CC(U)S is considered as needed, details should be set out as to minimum capture rate (e.g. >95% and duration of stable operating conditions), how permanent storage underground or permanent storage in products as per Commission Delegated Regulation (EU) 2024/2620 will be ensured and CO2 purity requirements see full set of specifications of the Northern Light project here.

Iron & Steel

- Blast Furnaces (BF) phase out by 2035, including a moratorium on BF relining and fossil-based production routes (including with CCS).
- 90% of the steel production comes from Electric Arc Furnaces (EAFs, scrap-based production route) by 2035
- EAFs are fed with 100% renewable electricity by 2040 (PPA / green certificates can also serve as evidence)
- Primary iron-ore based production is 100% directly electrified by 2050 using 100% renewable electricity (MOE or similar technologies).

Cement

- A 25% clinker-to-cement ratio by 2035[14]
- An increased electrification of kilns by 70% by 2050.
- Regarding cement recycling, even though the relative potential is lower than for other products like steel, the volume of available cement is so high that the absolute potential is still worth factoring in. Recycling of Portland cement is possible and creates the first zero-emissions alternative to existing cement production[15]. Furthermore, where possible and relevant, existing clinker production assets can also be used for the production of clinker substitutes – both on a permanent and switch on/off basis (e.g. https://www.juramaterials.ch/fr/materiaux-construction/ciments-liants-speciaux/jura-

[14] Horizon Europe, Data to Enable Transformation and Optimisation for Concrete Sustainability
[15] Dunant, C.F., Joseph, S., Prajapati, R. et al. Electric recycling of Portland cement at scale. Nature 629, 1055–1061 (2024). https://doi.org/10.1038/s41586-024-07338-8

eco3/juraeco3.html ; Cement produced in fully electrified and fossil-free rotary kiln - Power Engineering International)

- **Q8: Intermediate targets and milestones: intermediate targets and milestones provide a roadmap for achieving the specific quantitative time-bound targets. The milestones should detail key steps or achievements, such as obtaining permits, taking investment decisions for commissioning new techniques, starting operation of new techniques, while the intermediate targets should relate to interim emissions reductions.**

See Answer to Q5 and Q7, this is fully supported.

Actual deploy ability or scaling up indeed matters so to check robustness of assumptions made on delivery by the installation and replicability across the sector. However, the duration of obtaining a permit may depend on one country to another, it would be useful to indicated if a first of its kind permit is necessary for the permitting, not sure if this is needed information for the TP ambition check.

Information on whether the transformation will result in a change of the Seveso Directive hazard classification would however be very useful, in particular for safety gains obtained. Considering that many energy intensive industries are also Seveso classified, the positive implications for Seveso status related aspects should be highlighted, where relevant. This is particularly relevant for at source substitution of chemicals of concern (including physical hazards) contained in the EMS.

Milestones and targets should be assessed against the overarching principles and specific targets mentioned above. Under this heading, intermediate targets and milestones must provide a clear pathway to achieve them simultaneously. Using the Climate Neutrality Plans template[16], we suggest including as follows:

a) detailed description of the milestones for 2035 and for each five-year period thereafter, commensurate to the overarching principles and specific targets mentioned above;

b) specific yearly emission / resource use targets (percentage of reduction) for each pollutant/parameter, for 2035 and for each five-year period thereafter, at installation and sub-installation level (as appropriate):

c) absolute emission / resource use targets for 2035 for each pollutant / key resource (e.g. water) and for each five-year period thereafter, ensuring consistency with the historical emissions of the installation, the overarching principles mentioned above and the milestones referred to in point (a) of this point.

New elements brought by the IED would be the following:

1) details of measures with indication of environmental and climate performance on the various key performance indicators relating to “clean” and “circular”. The BAT criteria set in Annex III of the IED already provide clear expectations and the current BAT should be known to the operators as the performance baseline. In relation to climate, the format set under the EU ETS climate -neutrality plans could be used, so to ensure consistency as to minimal expectations for all operators (level playing field) and to enable comparability. Operators that provided already information through that means can simply cross link to those climate transition plans (unless information provided is outdated);

2) specifying the information that is of added value to the IED objectives such as cross-media impacts, technical applicability of transformative techniques and deploy-ability, resource efficiency related optimisation potential etc. The cross-media impacts considerations are a

[16] Commission Implementing Regulation (EU) 2023/2441

unique feature of the IED BAT determination process, they are relevant if certain decarbonisation techniques may generate negative trade-offs that need to be considered and mitigated;

3) cost and benefits information on the pathways explored, investment needs information and origin of funding (private or public);

4) Other information needed for INCITE to conclude on whether some technique options in the planning qualify as deep industrial transformative techniques;

5) Monitoring and progress tracking tools as well as requirements to improve useability of the information i.e. mandatory reporting through the EEA Industrial Emissions Portal.

- **Q9: Measures to achieve targets including techniques: this section outlines the practical measures and technologies planned to meet the targets, emphasising Best Available Techniques (BAT) and innovative approaches (e.g. emerging techniques). It should detail investments in emissions control, resource optimisation and process improvements.**

Agree that the above are essential. see Answer to Q8.

In addition, in order to better assess the impacts and measures and investments, as well as their consistency against the overarching principles, the following points should be considered by the operator:

1. Techniques preventing negative environmental, climate and human health impact should be prioritised over pollution reduction techniques (end of pipe). An effectiveness rating as to delivery of the techniques should be provided. Operators should quantify the pollution prevention gains compared to current BAT-AE(P)L levels, in particular whether these techniques can perform better than the stricter ranges. Relevant BAT-C codings should be used so to identify the relevant EU BREF sections more easily. The information provided should indicate most ambitious technical feasible level with external cost increase information v. strict BAT-AE(P)L baseline.

2. Improved benchmarking and compliance promotion tools so to track efforts made in delivery are set, those shall be user friendly for the actors involved (full ecosystem chain) Performance information should be reported in the metric of pollution intensities (g of a pollutant/ l of water consumed etc) per production outputs so to capture impact loads better. This is particularly relevant for pollutants that are persistent or bio accumulative as well as resource use indicators / waste generation.

3. Measures taken to improve transparency on the pollution life-cycle and compliance with relevant EU protection acquis as well as improved accuracy of monitoring data would also be a valuable information.

4. Ideally the TP should enable a benchmarking as to what the lowest ratio of 'environmental/climate impact of activities versus public good/service provided' in relation to current BAT performance and the EU ETS benchmark compliance (see point 2).

Estimated impacts of measures and investments:

- a quantitative and qualitative assessment of the estimated impacts on emissions reduction (GHG and other pollutants) of each measure and investment for each of the five-year periods including, to the extent feasible, a split of the overall impacts into the following categories:
    - fossil fuels and combustion processes phase out
    - switch to electrification and related technologies;

- energy efficiency and energy savings;
- resource efficiency, including reduced consumption of materials and recycling;
- material substitution to non-fossil-based alternatives

5. a description of the reasons why the measures described in point 6 abatement scenario were chosen rather than other potential measures, with regards to their estimated impacts.
6. Estimated (public) benefits from applying the abatement scenarios by applying the Value of Statistical Live method for air pollutants and assuming a carbon damage cost price set to at least (low range) 207€[17] per t CO2eq emitted and the high range scenario set to 353€/tCO2eq. For resource use impacts the method of quantification should be indicated.

- **Q10: Consideration of cross-media effects/impacts on other objectives: the transformation plan should evaluate potential cross-media effects, ensuring that measures to achieve one objective (e.g. emission reduction) do not inadvertently cause harm in another area (e.g. resource efficiency). This includes the identification of potential co-benefits as well.**

See Answer in "general comments" and in point 2 within Question 8.

The consideration of cross-media impacts is precisely the added value of the IED TP exercise compared to what currently exists (single focus on climate protection) and for a limited set of operators (the worst EU ETS operators).

The source origin of inputs (intra EU-extra EU) as well as amount of "critical" raw materials used may also be relevant for geopolitical reasons, it would be useful to indicate relevant implications.

- **Q11: What sector-specific elements should be reflected (if any) in the proposed content for the transformation plans?**

For key energy-intensive sectors (e.g. cement), it is important to highlight that existing roadmaps and transition plans (at EU, national, company and plant level) are developed almost exclusively from the side of clinker producers. As such, they fail to recognise the significant potential of enhanced circularity, as well as a reduced demand for clinker in the wider value-chain.

The impact on workers should be as well considered e.g. will the transformation ensure continued operation of the site thanks to the investments needed (guaranteeing a continued operation due to pay-back of investments made), require a new skillset, have implications on workforce (+/-).

Worker's health and safety impacts should also be quantified, which are sector specific / depend on quantities and hazard properties of substances used/produced on site (see Q8).

- **Q12: Do you anticipate any specific concerns in relation to confidential business information (CBI) with the drafting of transformation plans (e.g. planned investments), and do you have any suggestions on how this could be avoided?**

No. In most TP the cost estimates are transparently shared, which is needed to ensure credibility (underestimates/overestimates).

[17] This is based on the lower range 227USD /t CO2eq marginal damage cost price of the IPCC as used as well by the by the World Bank https://openknowledge.worldbank.org/server/api/core/bitstreams/253e6cdd-9631-4db2-8cc5-1d013956de15/content

Full transparency of the share of public funding is essential. Some market sensitive information, that may be considered as valid CBI by the public authorities in accordance with relevant rules may be presented in cost ranges.

Where there is a legitimate CBI concern (to be clearly defined), framework conditions can be put in place that the information is not visible to the competing stakeholder group i.e. industry operators but to other non-competing stakeholders i.e. COM, MS delegates and E.NGO delegates bound by a confidentiality agreement.