Policies to enable the Use of Waste as Alternative Fuel in Cement Production

A document to fulfil Cement and Concrete Breakthrough Priority Action C.1c and Priority Action C.3 with use of waste as an alternative fuel.

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Introduction to Cement and Concrete Breakthrough

Cement and Concrete Breakthrough is co-led by Canada and United Arab Emirates and has the following country members (as in December, 2025):

- Australia
- Austria
- Congo
- Egypt
- Ethiopia
- Germany
- Ireland
- Kenya
- Kingdom of Saudi Arabia
- Switzerland
- Türkiye
- United Arab Emirtes
- United Kingdom

The inaugural 2024-25 Priority Actions were launched in June 2024 and include deliverables and interim priority actions for COP30.

These priority actions focus on:

C1. Creating common definitions and standards for low carbon cement and concrete
C2. Supporting demand creation for low carbon cement and concrete
C3. Fostering greater innovation, education and collaboration around the decarbonization of the industry; and
C4. Strengthening the finance and investment landscape for decarbonization of the industry.

("C" differentiates cement and concrete actions from those in other sector breakthroughs.)

Cement and Concrete Breakthrough Priority Action C1.c

Priority Action C1.c: Develop a definition of 'alternative fuel' to enable the use of waste replacing coal in the context of cement production by COP30.

Document Purposes

1. Provide outcome to priority action C1.c (section 5.0 Acceptance and traceability of waste for co-processing)
2. Provide necessary context
   a. waste as an alternative fuel in cement kilns (sections 1.0, 2.0 and 3.0)

b. what governments can do to support this decarbonisation lever through policy. (section 4.0 Policy Recommendations)
c. industry commitments (section 6.0 GCCA Commitments)

1.0 Introduction

Co-processing of waste in cement kilns is an established, environmentally sound, and highly regulated waste management technology. It is a valuable option for a wide range of societal wastes. In contrast to energy recovery, co-processing does not only recover the energy content of the waste, but also recycles its mineral content into high value cement and concrete products. Co-processing results in the reduction of fossil fuels and primary materials consumption as well as reduction in waste disposal.

Co-processing describes the process in which wastes are used to replace fossil fuels and primary resources in clinker production, where clinker is a key ingredient of cement. Various types of wastes are suitable for co-processing, for example, plastics, paper, waste chemicals and tyres; some of which contain biogenic fraction.[1]

Where waste and by-products cannot be managed technically or economically by prevention, reduction, reuse or recycling, the cement manufacturing process provides a more ecologically sustainable solution, compared to waste-to-energy, incineration, or landfill, thanks to the full energy recovery and material recycling. Co-processing plays a critical role in preventing plastic pollution entering the environment as co-processing diverts plastic waste that cannot be recycled in another way from unsustainable options like landfill, or unsafe practices such as open burning.

The industry, through GCCA, has Best Available Techniques (BAT) and Best Environmental Practices (BEP) published in guidance documents. GCCA and its member companies follow the common understanding that avoiding and reducing waste is the best way of dealing with waste, but where waste arises, coprocessing offers the best solution for un-recyclable and un-reusable waste.

Co-processing is a waste management option that is used globally, given its benefits in managing wastes. For example, in Europe the cement sector is substituting on average 53% of its fossil fuel with waste derived fuels. Several cement plants already operate at about 100% substitution of fossil fuels. Globally, the figure is estimated to be only around 6% showing the further potential of managing wastes in cement kilns.

[1] Cembureau (2023): 2050 Ambitions & the role of biomass. Leaflet. Available at: https://cembureau.eu/media/qk0p2fj3/230404-biomass-waste-leaflet.pdf (Accessed: April 2024)
Cembureau (2023): Waste Materials for Co-processing. Video. Available at: https://www.youtube.com/watch?v=mG_VDUADs24 (Accessed: April 2024)

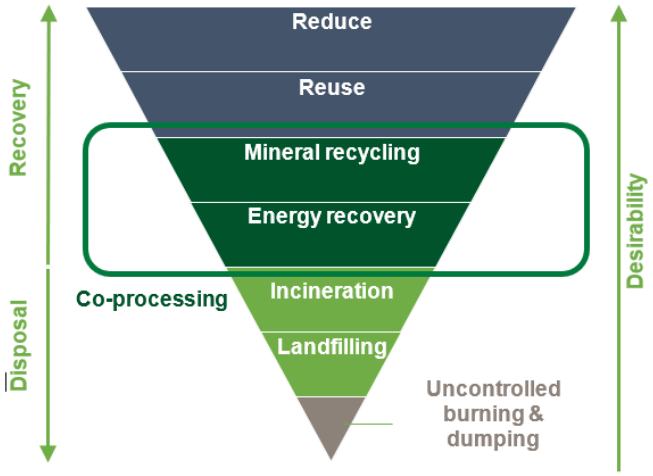

Figure 1: Co-processing in the waste management hierarchy[2]

2.0Benefits of Co-processing

Co processing benefits are listed below. Each of these is explained in more detail in annex 1.

1. Co-processing is a waste management option that is used globally
2. Co-processing is a highly regulated process & operated in line with Best Available Technology/ Best Environmental Practices[3]. It is a recognised environmentally sound waste-treatment option
3. Co-processing reduces global CO_2 emissions (figure 2) and global fossil fuel consumption
4. Co-processing helps reduce open waste burning and landfill
5. Co-processing is recognised as environmentally sound management even of hazardous waste
6. Co-processing reduces the need for public spending on waste incinerators and landfill
7. The cement sector is capable of using pre-processed wastes in its production processes and it does undertake the necessary investments
8. Co-processing reduces the amount of methane emissions from landfilling wastes
9. While incineration generates ashes, co-processing incorporates the mineral content into the product.
10. Co-processing does not impact product quality
11. Co-processing reduces the need for primary raw materials
12. Co-processing is both materials recycling and energy recovery

[2] GCCA Sustainability Guidelines for co-processing fuels and raw materials in cement manufacturing (2018): https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_FuelsRawMaterials-v0.pdf (accessed Jan 15th 2024)
[3] BAT: Best Available Technology; BEP: Best Environmental Practice

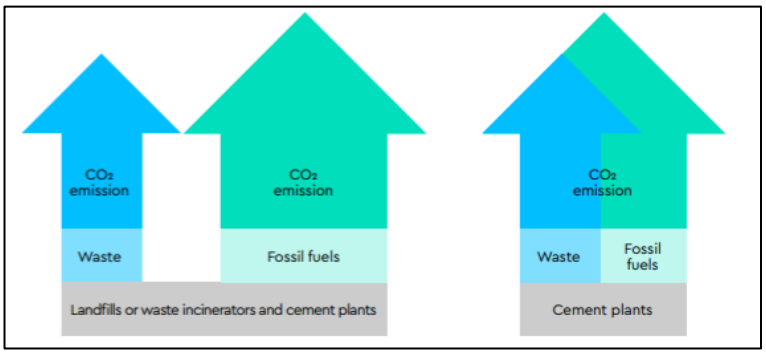

Figure 2 Utilisation of waste fuels in cement plants results – according to the Greenhouse Gas Protocol – in CO_2 and GHG emission reduction at landfills and incineration plants. (Source: GCCA 2050 Roadmap, p. 26)

3.0 Policy Context

Co-processing is included as a standalone operation in the recommendations of the Expert Working Group on the review of the Annex IV of the Basel Convention, which outlines in its Technical Guidelines, how co-processing is an environmentally sound waste management option for even hazardous wastes.

An increase in co-processing can be enabled by legislative and regulatory measures, that recognise this form of material recycling and energy recovery and its contribution towards achieving ambitious recycling targets. More specifically, supply chain logistics and infrastructure, permit-issuing, and waste policies like landfill taxes, that aim to reduce or even eliminate waste to landfill, will be required to support the cement industry in the increasing use of waste.

4.0 Policy Recommendations

Increasing co-processing in the cement sector will require the collaboration of governments and policy makers at municipal, regional, national, and global level to implement enabling policies in several areas, as follows.

1. Facilitate increased use of waste as alternative fuels and alternative raw materials in clinker (cement) production through:
    a. implementing policies to enable access to, and use of, suitable waste (see annexe 2) and secondary material streams, including biowaste, through policy measures that:
        i. reduce landfilling of waste that can be co-processed,
        ii. encourage segregation of waste streams to enhance resource flows,
        iii. enable environmental permit-issuing at the cement works.
    b. Providing a level playing field for the access and use of biomass across all sectors of the economy.

c. Formal recognition of the simultaneous energy recovery and mineral recycling characteristics of 'co-processing' in waste policy frameworks, including, at international level, the addition of a dedicated code (R15) for co-processing under Annex IV of the Basel Convention.
d. Monitoring and accounting of the share of materials which are effectively recycled through co-processing in a country's national recycling targets.

2. Regulation, permit-issuing, and compliance procedures (as already implemented in many parts of the world) to ensure implementation of Best Available Technologies when implementing co-processing in the cement industry.

5.0 Selection, Acceptance and Traceability of Waste for Co-processing[4]

Alternative fuels and raw materials must meet (physical and chemical) quality specifications, in the same way as primary fuels and raw materials. Processes must be in place to both determine the suitability of alternative fuels and raw materials, and, once identified, prepare them for use (pre-processing). The physical and handling properties of each new material must be understood and operators should ensure that appropriate storage and handling equipment is installed.

In the selection of alternative fuels and raw materials, the potential impacts on the clinker and cement manufacturing operations, product quality and the environment must be assessed prior to use. Detailed guidance is provided in the Annex but in particular the following shall be considered:

- Alkali, sulphur, chloride and trace element content
- Heat (calorific) value
- Water content
- Ash content
- Potential impact on stability of operation

In the acceptance of alternative fuels and raw materials from suppliers, the following should be considered:

- The relationship between the supplier and the cement plant should be defined by a commercial contract outlining the specifications to be met.
- All candidate alternative fuels and raw materials should be identified by source prior to acceptance. The materials should be pre-screened to ensure the receiving facility is fully aware of the composition of the materials. Full traceability of the waste streams is recommended.

[4] GCCA (2018): GCCA Sustainability Guidelines for co-processing fuels and raw materials in cement manufacturing GCCA_Guidelines_FuelsRawMaterials-v0.pdf (gccassociation.org) (Accessed June 2024)

- Suitable protocols should be developed and implemented governing the delivery and reception of alternative fuels and raw materials on the site.
- The acceptance criteria should be reviewed (and updated) on a regular basis in accordance with local regulation, and in cases where there are no regulations, at least annually.
- The use of alternative fuels and raw materials with high levels of heavy metals can have the potential to impact on either the environment or the product quality. The analytical equipment needed to perform the necessary tests to support screening and acceptance criteria should be available internally or at an accessible external lab.

Waste, which owing to its chemical composition, material properties or potential hazards, may influence the safety or operation of a cement plant, or whose use in a cement plant would lead to significant additional environmental impact, shall not be co-processed in cement plants. It is therefore necessary to specify quality requirements for the waste and in certain cases to restrict the use of particular wastes. As a consequence, the following is a list of waste materials that shall not be considered for co-processing in cement plants:

- Radioactive waste from the nuclear industry
- Electrical and electronic waste (e-waste)
- Whole batteries
- Corrosive waste, including mineral acids
- Explosives and ammunition
- Waste containing asbestos

6.0Role of Cement and Concrete Production Industry

The cement production industry has a role to implement, support and advocate for increased co-processing in our industry. They can:

1. Increase globally the use of waste in cement production, thereby reducing waste incineration, landfill, emissions from landfill, open burning, and plastic pollution.
2. Focus on materials which were derived from waste, and which cannot be recycled in another way.
3. Comply with the GCCA guidelines for co-processing fuels and raw materials and guidelines for the monitoring and reporting of air emissions.
4. Collaborate to promote good co-processing practices, capacity building, standards and enabling policies.
5. Engage with national and local authorities as well as value chain partners (e.g., equipment suppliers) as a reliable partner on waste management to implement and ensure waste management in line with local requirements.
6. Engage transparently with communities on waste consumption in cement plants.
7. Continuously improve production processes to reduce energy consumption and CO_2 emissions.

Annexe 1: Benefits of Co-processing

1. **Co-processing is a waste management option that is used globally**, given its benefits in managing wastes. For example, in Europe the cement sector is substituting on average 53% of its fossil fuel with waste derived fuels.[5] Several cement plants already operate at about 100% substitution of fossil fuels. Globally, the figure is estimated to be around 6% showing the further potential of managing wastes in cement kilns.

2. **Co-processing is a highly regulated process & operated in line with Best Available Technology/ Best Environmental Practices[6]. It is a recognised environmentally sound waste-treatment option[7].** Long retention times, high temperatures and strict control of chlorine levels mean cements kilns have lower emissions to air than waste incineration plants. Waste materials undergo a rigorous acceptance and inspection procedure before being used in cement kilns. Application of Best Available Techniques (BAT) and Best Environmental Practices (BEP) ensure a high level of protection of human health and the environment.[4,8,9,10] For example, the European Union regulates air emissions from industry, including cement manufacture.[5,11] Installations operate in accordance with a corresponding permit. Air emissions are measured according to specified provisions to ensure compliance with the limit values, and these are published on a regular basis. GCCA has Guidelines for the monitoring and reporting of emissions.

   The UNEP Basel Convention Technical Guidelines for waste co-processing provide instructions for the use of waste as alternative fuels in cement kilns. These address concerns of potential toxic emissions such as furans and dioxins when the conditions in the kilns are not properly controlled. Guidance must be followed, and close monitoring and quality control are essential to avoid negative impacts. The local regulations must provide strict control points for the cement kiln operation.

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[5] Cembureau (no year): "What is Co-Processing". Available at: https://cembureau.eu/media/hbdhpv0s/what-is-co-processing-brochure_pm-version.pdf (Accessed: December 2023)
[6] BAT: Best Available Technology; BEP: Best Environmental Practice
[7] UNEP Basel Convention (2011): Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns: as adopted by the 10th meeting of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (decision BC-10/8), Cartagena, Colombia.
[8] JRC (2013): Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide (europa.eu) (Accessed: January 2024)
[9] GTZ/LafargeHolcim (2020): Guidelines on Pre- and Co-processing of Waste in Cement Production. Use of wastes as alternative fuels and raw materials. giz-2020_en_guidelines-pre-coprocessing.pdf (Accessed: January 2024)
[10] GCCA (2018): GCCA Sustainability Guidelines for co-processing fuels and raw materials in cement manufacturing GCCA_Guidelines_FuelsRawMaterials-v0.pdf (gccassociation.org) (Accessed: January 2024)
[11] European Commission (2010): Industrial Emission Directive 2010/75EU. EUR-Lex - 02010L0075-20110106 - EN - EUR-Lex (europa.eu) (Accessed: January 2024)

3. **Co-processing reduces global CO_2 emissions and global fossil fuel consumption**, as it reduces the amount of waste that is incinerated or sent to landfill. As wastes are shifted from incinerators to co-processing in cement kilns, the amount of CO_2 emissions from waste incinerators are reduced. Additionally, cement kilns reduce their demand for fossil fuels although the consumption of waste derived fuel is often associated with a small but appreciable increase in kiln fuel consumption overall. Due to the high temperatures in the clinker kiln, the cement sector can substitute fossil fuels with fuels derived from waste. Using waste as fuel in the cement sector, therefore helps to increase the energy security of a country, as there is less competition for fossil fuels.

4. **Co-processing helps reduce open waste burning and landfill.** In countries which lack a sound waste management system, co-processing offers the opportunity to divert waste away from open burning and landfill to existing cement kilns. This reduces the demand for investment in other waste management options and is a solution already available.[11]However, some pre-conditions need to be in place. Countries must develop waste collection, waste separation and regulation on co-processing; cement companies have to build up know-how and skills on co-processing and they also need to make the necessary investments in equipment. Most countries have cement kiln production capacities and the key advantages of using them are the reduced investment requirements and the capacity to deal with plastic and other wastes on an industrial scale from plastic hotspots or mining efforts from landfill and dumpsites[12]. With this approach, the energy content in non-recyclable plastic waste can be harnessed to produce clinker, while reducing the reliance on fossil fuels.[6]

   A 2023 UNEP report[13] looked into the causes of plastic pollution and proposed a system change scenario for the future. The scenario suggests that intermediate solutions will be needed to prevent plastics that cannot be eliminated or recycled from becoming pollution. The UNEP report urges governments to assess whether cement kilns may be available for the safe disposal of non-circular plastic and for avoiding plastic pollution.

5. **Co-processing is recognised as environmentally sound management even of hazardous waste.** The Basel Convention, which is led by the United Nations Environmental Programme (UNEP), published technical guidelines[14] where the

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[12] A Sharma, V Aloysius, C Visvanathan (2019): Recovery of plastics from dumpsites and landfills to prevent marine plastic pollution in Thailand,
Waste Disposal & Sustainable Energy, Springer

[13] UNEP (2023): "Turning off the Tap: How the world can end plastic pollution and create a circular economy"
https://www.unep.org/resources/turning-off-tap-end-plastic-pollution-create-circular-economy

[14] Basel Convention (2024):
https://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx (Accessed: January 2024)

role of co-processing is recognised as an environmentally sound management process for hazardous wastes:

"Co-processing of wastes in properly controlled cement kilns provides energy and materials recovery while cement is being produced, offering an environmentally sound recovery option for many waste materials. As countries strive for greater self-sufficiency in hazardous waste management, particularly in developing countries that may have little or no waste management infrastructure, properly controlled co-processing can provide a practical, cost-effective, and environmentally preferred option to landfill and incineration. In general, co-processing of waste in resource-intensive processes can be an important element in a more sustainable system of managing raw materials and energy."[12]

Furthermore, for some chemical substances, for example, wastes containing Persistent-Organic-Pollutants (POPs), the Basel Convention Technical Guidelines, acknowledge that co-processing in cement kilns provide a technology to safely destroy POPs, while waste incinerators and landfill are not seen as environmentally sound waste management options for these substances.

6. **Co-processing reduces the need for public spending on waste incinerators and landfill.** By using waste derived fuels, the cement sector can use waste that would otherwise be incinerated or sent to landfill. Thus, public investments in incineration plants and landfill are reduced. Hence, co-processing can play and indeed, already plays a key role in waste management in local communities and municipalities in most countries. Especially where proper waste management is low.[11]

7. **The cement sector is capable of using pre-processed wastes in its production processes and it does undertake the necessary investments.** While using existing cement kilns requires smaller investments than building new waste management options, using pre-processed wastes in cement kilns does not come without costs. Waste needs to be collected from landfill, dump sites and other locations. Alternatively, waste separation mechanisms need to be rolled out and applied. Then the waste needs to be pre-processed into suitable alternative fuels. Investment is also required to address quality assurance through laboratory testing facilities. This ties in with the health and safety aspects that should be considered to mitigate risks in all steps of the process.

8. **Co-processing reduces the amount of methane emissions from landfilling wastes.**[15] Biogenic waste if sent to landfill or disposed of in an uncontrolled manner can lead to emissions of methane, a gas with significantly greater global warming potential than carbon dioxide. But these methane emissions can be avoided if this waste is redirected to cement kilns.

9. **While incineration generates ashes, co-processing incorporates the mineral content into the product.** In some circumstances, particularly at high waste fuel usage rates, the amount of kiln dust might increase and is typically incorporated into the final product.

10. **Co-processing does not impact product quality.** Co-processing may change the metal concentrations in cement products which are in turn integrated in the concrete or mortar matrix. Risk of release from the concrete matrix has been the subject of numerous research studies over the last 20 years and there is substantial evidence that the use of selected waste as alternative fuel has no negative impact on the environmental quality of the product. The recyclability of concrete and mortar also remains completely unaffected.

11. **Co-processing reduces the need for primary raw materials.** As the mineral content of the waste substitutes raw materials into the clinker and eventually into concrete, co-processing also reduces the use of primary raw materials. About 5% of the raw materials needed in the production of the cement clinker in Europe consists of recycled material and ashes from alternative fuels.[2]

12. **Co-processing is both materials recycling and energy recovery.** In addition to the energy recovery, the mineral fraction from the waste is incorporated in the product, which is clinker, the key ingredient of cement. Co-processing is thus the combination of simultaneous material recycling and energy recovery from pre-treated waste in a thermal process, which replaces natural mineral resources and fossil fuels such as coal and petroleum products.

    An ISO standard[16] expected to be published in July 2024, defines a global methodology for the calculation of the part of solid recovered fuels, which is recycled when used in cement kilns. The Spanish Cement and Environment Labour Foundation, CEMA, has conducted a study[17] to measure the recycling

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[15] Rocky Mountains Institute (2023): Waste Methane 101: Driving Emissions Reductions from Landfills. https://rmi.org/waste-methane-101-driving-emissions-reductions-from-landfills/#:~:text=Landfills%20emit%20methane%20diffusely%20through,inefficient%20flares%2C%20among%20other%20causes. (Accessed: January 2024)

[16] ISO DIS 4349 "Determination of the Recycling Index for co-processing" for the Solid Recovered Fuels (SRF), under the ISOs Technical Committee 300.

[17] CEMA (2023): Co-processing – Material recovery of the mineral fraction from Refuse-Derived Fuels in the cement industry. https://www.fundacioncema.org/wp-content/uploads/2023/12/ESTUDIO-COPROCESADO-2023-ENG-1.pdf (Accessed: January 2024)

index (R-index) of 63 samples of waste used in the cement industry. The R-index was found to be in the range of up to 26%, depending on the waste types.[18]

[18] Waste types include e.g. Refuse Derived Fuels (RDF) industrial, RDF municipal, animal meal, sewage sludge, End-of-life vehicles, wood waste