



Summary

Guidelines on Co-processing Waste Materials in Cement Production

The GTZ-Holcim Public Private Partnership

SUMMARY

Greenhouse gases and global warming, the efficient use of non-renewable fossil fuels, toxic residues, and the contamination of water and soil are in the forefront of ecological concerns and public discussions. Cost competitiveness, global competition and profitability are the concerns of business. The challenge facing today's society is to balance environmental protection and economic interest.

Poor waste management is an issue in developing countries and in countries in transition. In many of these countries, waste is discharged to sewers, buried or burned on company premises, illegally dumped at unsuitable locations, or taken to landfills that fail to meet requirements for the environmentally sound final disposal of waste. This can cause contamination of soil, water resources, and the atmosphere, leading to the sustained deterioration of the living conditions and health of the adjacent populations. Toxic substances and persistent compounds escape into the environment, are spread through the air over large areas, and can enter the food chain, affecting human and animal health.

Several factors can cause these problems:

- Not all developing countries have an integrated waste management strategy and only a few can offer an appropriate technical infrastructure for disposing of waste in a controlled and environmentally sound manner
- Although in many cases laws concerning the controlled handling of waste exist, they are often not properly enforced
- Uncontrolled disposal is usually the cheapest way to get rid of the waste, and the waste generators tend to be unwilling to pay much for adequate disposal
- Policy makers rarely pay enough attention to the subject of waste management, and may know little about the consequences for human health or the high cost of the remediation of the damage caused by uncontrolled waste disposal.

There is general agreement that there is an urgent need to improve waste management, and different solutions are being discussed. Waste avoidance, cleaner production, producer responsibility, supply chain management or sustainable use of natural resources are only a few of the strategies being promoted. In spite of technological progress and an increasing social and political

awareness, the problem of growing waste streams persists. The "zero waste society" is a worthy vision, but we are far from realizing it. Modern incineration plants and secure landfills are common disposal options in OECD countries but have high investment and operating costs and need qualified personnel.

One proved alternative and possible solution is the **co-processing** of selected waste materials in the cement industry. An efficient cement kiln can provide an environmentally sound and cost-effective treatment/recovery option for a number of wastes.

*Co-processing refers to the use of waste materials in industrial processes, such as cement, lime, or steel production and power stations or any other large combustion plant. In a few cases this process is also called co-incineration, but we recommend to name it co-processing as the main objective is not the final disposal of waste, but rather the substitution of **primary fuel and raw material** by waste. It is a recovery of energy and material from refuse.*

Different types of wastes have been successfully co-processed as alternative **fuels and raw materials (AFR)** in cement kilns in Europe, Japan, USA, Canada and Australia since the beginning of the 1970s. The use of AFR can decrease the environmental impacts of wastes, safely dispose of hazardous wastes, decrease greenhouse gas emissions, decrease waste handling costs and save money in the cement industry. It will help in achieving the targets set in Agenda 21 of the "Earth Summit" in Rio de Janeiro (1992), the Johannesburg Declaration on Sustainable Development (2002) and the Millennium Development Goals.

To promote co-processing of waste in cement kilns the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ), and Holcim Group Support LTD (Holcim) have formed a strategic alliance. Holcim Group Support LTD (Holcim) is a worldwide leading supplier of cement and aggregates as well as value-adding activities such as ready-mix concrete and asphalt, including services. GTZ is an international cooperation enterprise for sustainable development with worldwide operations.

GENERAL PRINCIPLES FOR CO-PROCESSING

In order to ensure sustainably sound co-processing, we must understand and respect the following **general principles**:

Principle I	<p>Co-processing respects the waste hierarchy:</p> <ul style="list-style-type: none"> → Co-processing does not hamper waste reduction efforts, and waste shall not be used in cement kilns if ecologically and economically better ways of recovery are available. → Co-processing shall be regarded as an integrated part of modern waste management, as it provides an environmentally sound resource recovery option for the management of wastes. → Co-processing is in line with relevant international environmental agreements, namely the Basel and Stockholm Conventions.
Principle II	<p>Additional emissions and negative impacts on human health must be avoided:</p> <ul style="list-style-type: none"> → To prevent or keep to an absolute minimum the negative effects of pollution on the environment as well as risks to human health. → On a statistical basis, emissions into the air shall not be higher than those from cement production with traditional fuel.
Principle III	<p>The quality of the cement product remains unchanged:</p> <ul style="list-style-type: none"> → The product (clinker, cement, concrete) shall not be abused as a sink for heavy metals. → The product should not have any negative impact on the environment as e.g. demonstrated with leaching tests. → The quality of cement shall allow end-of-life recovery.
Principle IV	<p>Companies engaged in co-processing must be qualified:</p> <ul style="list-style-type: none"> → Have good environmental and safety compliance track records and to provide relevant information to the public and the appropriate authorities. → Have in place personnel, processes, and systems demonstrating commitment to the protection of the environment, health, and safety. → Assure that all requirements comply with applicable laws, rules and regulations. → Be capable of controlling inputs and process parameters required for the effective co-processing of waste materials. → Ensure good relations with the public and other actors in local, national and international waste management schemes.
Principle V	<p>Implementation of co-processing has to consider national circumstances:</p> <ul style="list-style-type: none"> → Country specific requirements and needs must be reflected in regulations and procedures. → A stepwise implementation allows for the build-up of required capacity and the set-up of institutional arrangements. → Introduction of co-processing goes along with other change processes in the waste management sector of a country.

The objective of this joint initiative is to prepare internationally recognized Guidelines on "Co-processing of Waste Materials in Cement Production" and its model application in selected countries. The Guidelines developed by this cooperation include some basic rules and principles that should be observed when co-processing waste materials.

This means AFR use should respect the waste hierarchy, be integrated into waste management programs, support strategies for resource efficiency and not hamper waste reduction efforts. Following certain basic rules assures that the use of AFR does not have negative impacts on cement kiln emissions. Co-processing should not harm the quality of the cement produced.

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SPECIFIC PRINCIPLES FOR CO-PROCESSING

Furthermore the Guidelines include specific principles and requirements for co-processing of waste in cement kilns including the observation of and compliance with all applicable laws and regulations, environmental aspects of cement production and AFR pre-processing, operational issues, occupational health and safety as well as communication and corporate social responsibility.

Principles related to legal aspects

(→ See **principles 1-3** on page 5)

Countries considering co-processing need appropriate legislative and regulatory frameworks. National laws should define the basic principles under which co-processing takes place and define the requirements and standards for co-processing. Regulators and operators should conduct baseline tests with conventional fuels and materials so they can compare AFR results to these. Some wastes should never be co-processed; these range from unsorted municipal garbage and certain hospital wastes to explosives and radioactive waste. Other wastes will need pre-processing before they can be used, and approaches to AFR use should take account of the need to effectively regulate and manage these pre-processing plants.

Principles related to environmental aspects

(→ See **principles 4-7** on page 5)

Following certain basic rules assures that the use of AFR does not change the emissions of a cement kiln stack. These include feeding alternative fuels into the most suitable zones of the kiln, feeding materials that contain a lot of volatile matter into the high temperature zone only, and avoiding materials that contain pollutants which kilns cannot retain, such as mercury. Emissions must be monitored, some only once a year and others continuously. Environmental impact assessments (EIA) should be done to confirm compliance with environmental standards; risk assessments can identify any weaknesses in the system, and material flux and energy flow analyses help to optimize the use of resources.

Principles related to operational issues

(→ See **principles 8-12** on page 6)

Cement plant operators using AFR shall ensure their traceability from reception up to final treatment. Transport of wastes and AFR must comply with regulations.

Plants must have developed, implemented and communicated to employees adequate spill response and emergency plans. For start-up, shut-down and conditions in between, strategies for dealing with AFR must be documented and available to plant operators. Plants need well-planned and functioning quality control systems, as well as monitoring and auditing protocols.

Principles related to occupational health and safety

(→ See **principles 13-17** on page 7)

Risks can be minimized by properly locating plants in terms of environmental setting, proximity to populations and settlements, and the impact of logistics and transport. Cement and pre-processing plants will require good infrastructure in terms of technical solutions for vapors, odors, dust, infiltration into ground or surface waters, and fire protection. All aspects of using AFR must be well documented, as documentation and information are the basis for openness and transparency about health and safety measures, inside and outside the plant.

Management and employees must be trained in handling and processing of AFR. Hazardous operations training for new workers and subcontractors should be completed before starting with co-processing. Periodic re-certification should be done for employees and subcontractors. All visitors and third parties should receive an induction training. Understanding risks and how to mitigate them are keys to training. Training authorities is the basis for building credibility.

Principles related to communication and social responsibility

(→ See **principles 18-22** on page 7)

Introducing AFR requires open communication with all stakeholders. Provide all the information stakeholders need to allow them to understand the purposes of co-processing, the context, the functions of parties involved, and decision-making procedures. Open discussions about good and bad experiences are part of transparency, leading to corrective actions. Be credible and consistent, cultivating a spirit of open dialogue and respect for differing cultures.

PRINCIPLES RELATED TO LEGAL ASPECTS	Principle 1	<p>An appropriate legislative and regulatory framework shall be set up:</p> <ul style="list-style-type: none"> → Co-processing shall be integrated into the overall legislation concerning environmental protection and waste management before it can be accepted as a viable waste management alternative. → Legally-binding regulations and standards are necessary to guarantee legal security and to assure a high level of environmental protection. → Law enforcement is the key to successful AFR implementation and marketing.
	Principle 2	<p>Baselines for traditional fuels and raw materials shall be defined:</p> <ul style="list-style-type: none"> → Control and monitor inputs, outputs, and emissions during the operation of the cement plant with virgin fuel and primary raw materials. → Evaluate the given environmental situation prior to starting waste co-processing. → Use this baseline data to define potential impacts of AFR on the environment based on standardized Environmental Impact Assessments (EIA).
	Principle 3	<p>All relevant authorities should be involved during the permitting process:</p> <ul style="list-style-type: none"> → Build credibility with open, consistent, and continuous communications with the authorities. → Consider and strive to apply Best Available Technology (BAT). → The cement plant operator shall provide necessary information to enable authorities to evaluate the option of co-processing. → Install community advisory panels early, including the authorities, to facilitate the exchange of information, opinion and know-how.
PRINCIPLES RELATED TO ENVIRONMENTAL ASPECTS	Principle 4	<p>Rules must be observed</p> <ul style="list-style-type: none"> → The use of AFR does not have a negative impact on the emissions from a cement kiln stack, if the following rules are observed: <ul style="list-style-type: none"> – all alternative fuels must be fed directly into the high-temperature zones of a kiln system (i.e. via main burner, mid kiln, transition chamber, secondary (riser duct) firing, precalciner firing) – the same is true for alternative raw materials with elevated amounts of volatile matter (organics, sulfur) – the concentration of pollutants in alternative materials for which the cement process has insufficient retention capability (like Hg) shall be limited → Cement production lines shall be equipped with a system capable of feeding operation filter dust directly to the cement mills.
	Principle 5	<p>Emission monitoring is obligatory:</p> <ul style="list-style-type: none"> → Emissions must be monitored in order to demonstrate: <ul style="list-style-type: none"> – compliance with the national regulations and agreements – compliance with corporate rules – the reliability of the initial quality control of the process input materials.
	Principle 6	<p>Pre-processing of waste is required for certain waste streams:</p> <ul style="list-style-type: none"> → For optimum operation, kilns require very uniform raw material and fuel flows in terms of quality and quantity. This can only be achieved for certain types of waste by pre-processing the waste.
	Principle 7	<p>Environmental impact assessments (EIA) confirm compliance with environmental standards:</p> <ul style="list-style-type: none"> → Risk assessments are an efficient way to identify weaknesses in the system. → Material flux and energy flow analyses help to optimize the use of resources.

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PRINCIPLES RELATED TO OPERATIONAL ISSUES	Principle 8	<p>The sourcing of waste and AFR is essential:</p> <ul style="list-style-type: none"> → Traceability of waste helps to avoid undesired emissions, to minimize operational risks and to ensure final product quality. → Traceability shall be ensured at the pre- or co-processing facility from reception up to final treatment. → Business agreements with regular customers (waste producers, waste handling companies) shall include quality and delivery criteria to allow for a uniform waste stream. → Waste categories unsuitable for co-processing should be refused. → All candidate (new) wastes will be subject to a detailed source qualification test procedure prior to acceptance.
	Principle 9	<p>Materials transport, handling, and storage must be monitored:</p> <ul style="list-style-type: none"> → General Guidelines for waste and AFR transportation must comply with regulatory requirements. → Instructions and adequate equipment for transport, handling, and storage of solid and liquid wastes and AFR are provided and maintained regularly. → Conveying, dosing, and feeding systems are designed to minimize fugitive dust emissions, to prevent spills, and to avoid toxic or harmful vapors. → Adequate spill response and emergency plans must be developed, implemented, and communicated to plant employees.
	Principle 10	<p>Operational aspects must be considered:</p> <ul style="list-style-type: none"> → AFR will be fed to the kiln system only at appropriate introduction points determined by the characteristics of the AFR. → The technical conditions of the plant that influence emissions, product quality, and capacity will be carefully controlled and monitored. → For start-up, shut-down, or upset conditions of the kiln, the strategy dealing with the AFR feed has to be documented and must be accessible to operators.
	Principle 11	<p>Quality control system is a must:</p> <ul style="list-style-type: none"> → Documented control plans for wastes and AFR must be developed and implemented at each pre-processing or co-processing site. → Procedures, adequate equipment, and trained personnel for the control of wastes and AFR must be provided. → Appropriate protocols in case of non-compliance with given specifications must be implemented and communicated to operators.
	Principle 12	<p>Monitoring and auditing allow transparent tracing:</p> <ul style="list-style-type: none"> → Monitoring and auditing protocols for waste and AFR management in pre- and co-processing installations are developed and implemented. → Instructions and adequate training of company staff in performing internal audits are provided.

PRINCIPLES RELATED TO OCCUPATIONAL HEALTH AND SAFETY	Principle 13	<p>Site suitability avoids risks:</p> <ul style="list-style-type: none"> → Proper location (environmental, proximity to populations of concern, impact of logistics/transport); good infrastructure (technical solutions for vapors, odors, dust, infiltration into ground or surface waters fire protection etc.) and properly trained management and employees with regard to the handling and processing of AFR can all minimize risks.
	Principle 14	<p>Safety and security:</p> <ul style="list-style-type: none"> → Each site must have a unit for safety and security. → A risk manager is responsible for the arrangement and performance of the unit.
	Principle 15	<p>Documentation and information is a must:</p> <ul style="list-style-type: none"> → Documentation and information are the basis for openness and transparency about health and safety measures. → Information must be available for employees and authorities before starting any co-processing activity.
	Principle 16	<p>Training should be provided at all levels:</p> <ul style="list-style-type: none"> → Management should be trained before starting with co-processing at a new facility or site. Field visits at already existing facilities are strongly recommended. → Hazardous operations training for new workers and sub-contractors should be completed before starting with co-processing. Periodic re-certification should be done for employees and sub-contractors. Include induction training for all visitors and third parties. → Understanding risks and how to mitigate them are key to training. → Training and information of authorities is the basis for building credibility.
	Principle 17	<p>Emergency and spill response plans:</p> <ul style="list-style-type: none"> → Good, regular emergency and spill response planning and emergency response simulations, including the neighboring industries and the authorities, contribute to the safe use of AFR.

PRINCIPLES RELATED TO COMMUNICATION AND SOCIAL RESPONSIBILITY	Principle 18	<p>Openness and transparency:</p> <ul style="list-style-type: none"> → Provide all necessary information to allow stakeholders to understand the purpose of co-processing, the context, the function of parties involved and decision-making procedures. → Open discussions about good and bad experiences / practices are part of transparency.
	Principle 19	<p>Credibility and consistency:</p> <ul style="list-style-type: none"> → Build credibility by being open, honest and consistent. Rhetoric must be matched with demonstrated facts and good performance. Gaps between what you say and what you currently do must be avoided.
	Principle 20	<p>Cultivating a spirit of open dialogue, based on mutual respect and trust:</p> <ul style="list-style-type: none"> → Communication also means seeking feedback and dialog with stakeholders and integrating external views. Participants in stakeholder engagement activities must be able to express their views without fear of restriction or discipline.
	Principle 21	<p>Cultural sensitivity:</p> <ul style="list-style-type: none"> → Take into account the different cultural environments in which we operate. Be target-oriented and truthful.
	Principle 22	<p>Continuity:</p> <ul style="list-style-type: none"> → Start early; and once you start, never stop.

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CONCLUSION

As populations increase in the developing world, so do waste management problems, and so does the need for more cement and concrete for housing and the infrastructure of development. The properly managed use of wastes as fuels and raw materials in cement kilns can help manage wastes while contributing to the sustainable development of our world.

These Guidelines on co-processing waste materials in cement production are meant to gather the lessons of the gained experience from industrialized countries and offer it particularly to developing countries that need to improve approaches to waste management. They encourage the private sector to develop techniques and know-how regarding co-processing and engage the public sector to apply and maintain environmental as well as occupational health and safety regulation standards.

The Guidelines have been prepared by experts from **Holcim** and **GTZ**. Support and advice was given by a variety of external stakeholders from public and private sector as well as from the cement industry and from organizations working in international development cooperation. The elaboration of the document was coordinated by the **Institute for Copreneurship (IEC) of the University of Applied Sciences Northwestern Switzerland (FHNW)**.

GTZ and Holcim would like to express their sincere gratitude to all involved parties for their engagement and comments. Our thanks also go to BMZ for financing the public part of the project.



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The public part is being financed by:



Federal Ministry
for Economic Cooperation
and Development

