Co-processing of Plastic Waste in Cement Kilns

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‘Waste’ as defined

- Wastes have been understood globally to mean substances or objects that are :-
    - ❖ Disposed of, intended to be disposed of, or required to be disposed of under provisions of national law.

- World generated 242 million tonnes of plastic waste ie. 12% of all municipal solid waste (2016).

- India generated close to 55 mTPA of MSW out of which approx. 3.4 mTPA (6.3%) accounts to plastic waste (2020-21)

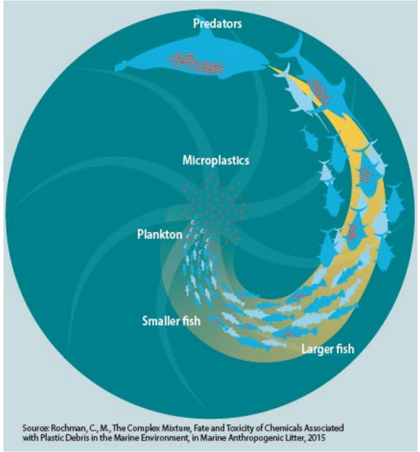
Global Plastic Waste

- Plastic consumption **quadrupled** over past 30 years, driven by growth in emerging markets.
- Global plastics production **doubled** from 2000 to 2019 to reach 460 million tonnes.
- Global plastic waste generation **more than doubled** from 2000 to 2019 to 353 mt.
- Two-thirds of plastic waste comes with lifetimes of under five years, with 40% coming from packaging, 12% from consumer goods and 11% from clothing and textiles.
- Only 9% of plastic waste is recycled (15% is collected for recycling but 40% of that is disposed of as residues).
- 19% is incinerated, **50% ends up** in landfill and **22% evades waste management systems** and goes into uncontrolled dumpsites, is burned in open pits or ends up in terrestrial or aquatic environment.

Source: OECD

Impacts of plastics are evident

- Impact on biodiversity, marine animals (mammals, fish, turtles and birds): **More plastics than fishes in oceans by 2050** (MacArthur et al)
- Microplastics in food chain : **People ingesting 5 grams of microplastics every week** equivalent of a credit card WWF and University of Newcastle, Australia)
- GHGs associated with plastics is to grow to 2.1 GtCO2e by 2040, or **19% of global carbon budget**.
- **Economic costs of marine plastic** are estimated to (US$) 6-19 billion globally in 2018 (incl. impacts on tourism, fisheries and aquaculture and costs of cleanups)
- Global plastic market in 2020 is ~US$ 580 billion while **losses of marine natural capital** is US$ 2,500 billion per year
- **Others impacts**: Landfill leachates, Risk to coral reefs, clogging of drains and urban floods, aesthetics



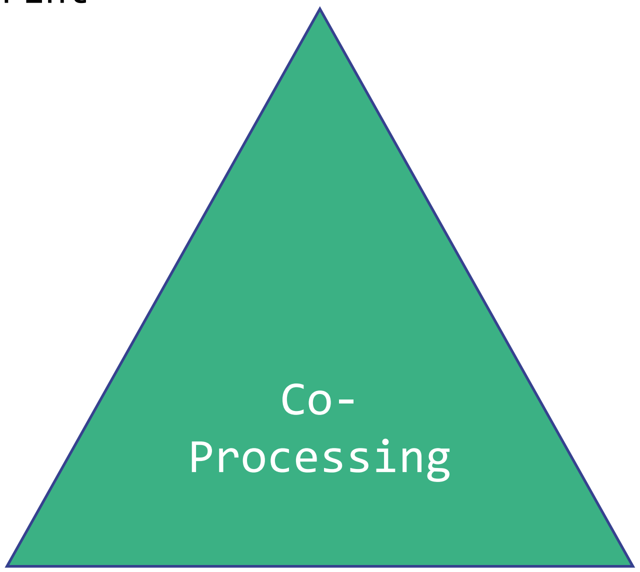
Co-processing : A viable option

- Co-processing in cement kilns deals primarily with recovery of energy through the use of suitable waste material that cannot be recycled or reused, i.e. through substitution of fossil fuel and virgin raw materials.

- In absence of available treatment options and urgent needs, a feasible cement kiln can be used for treatment of potential streams of waste including hazardous constituents under strict compliance of local rules and regulations.

A WIN-WIN SITUATION

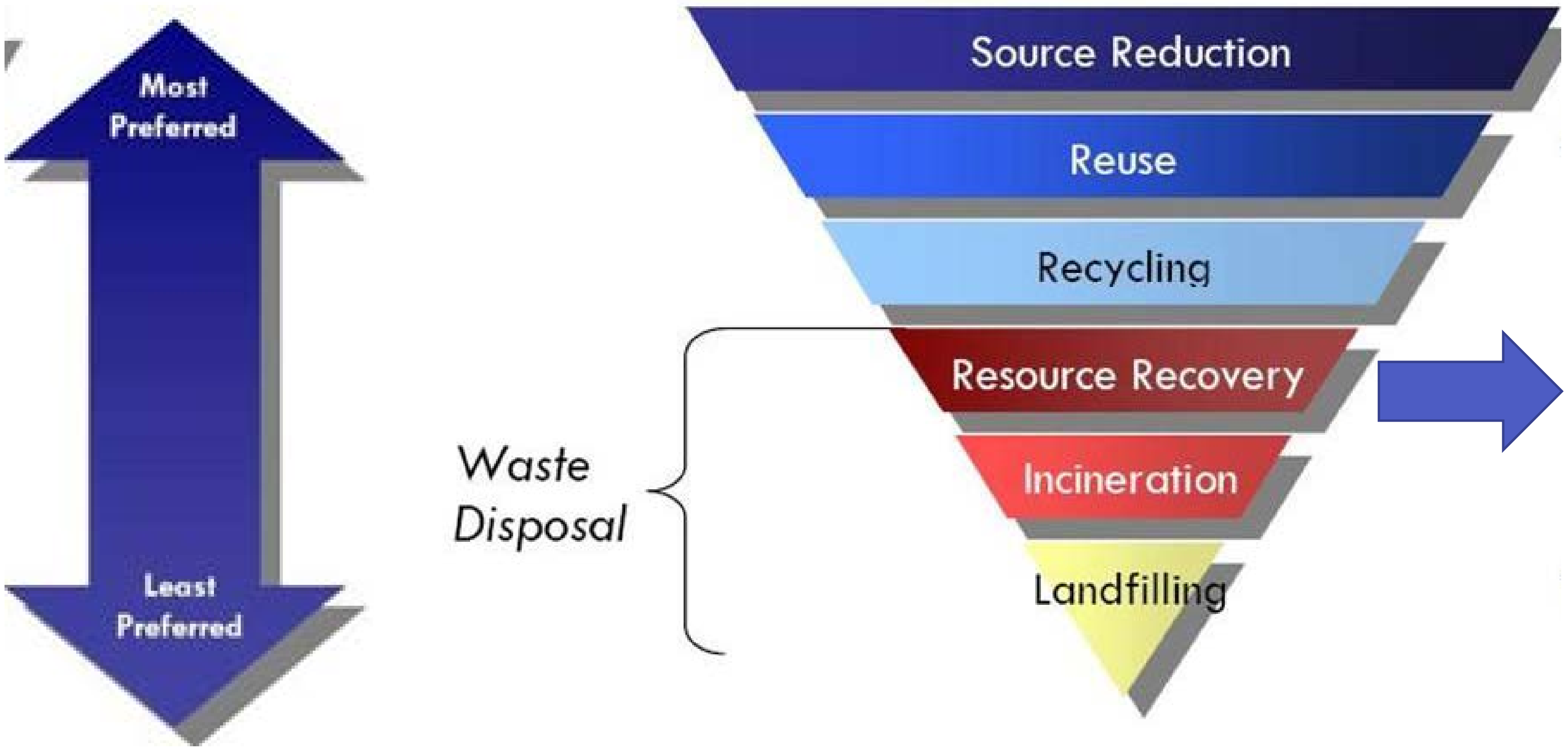
Industry: Cost Effective substitution of natural resource + Reduced Footprint



Waste Management: Environmentally Sustainable Solution for waste Management

Positive impact on Climate Change

Hierarchy

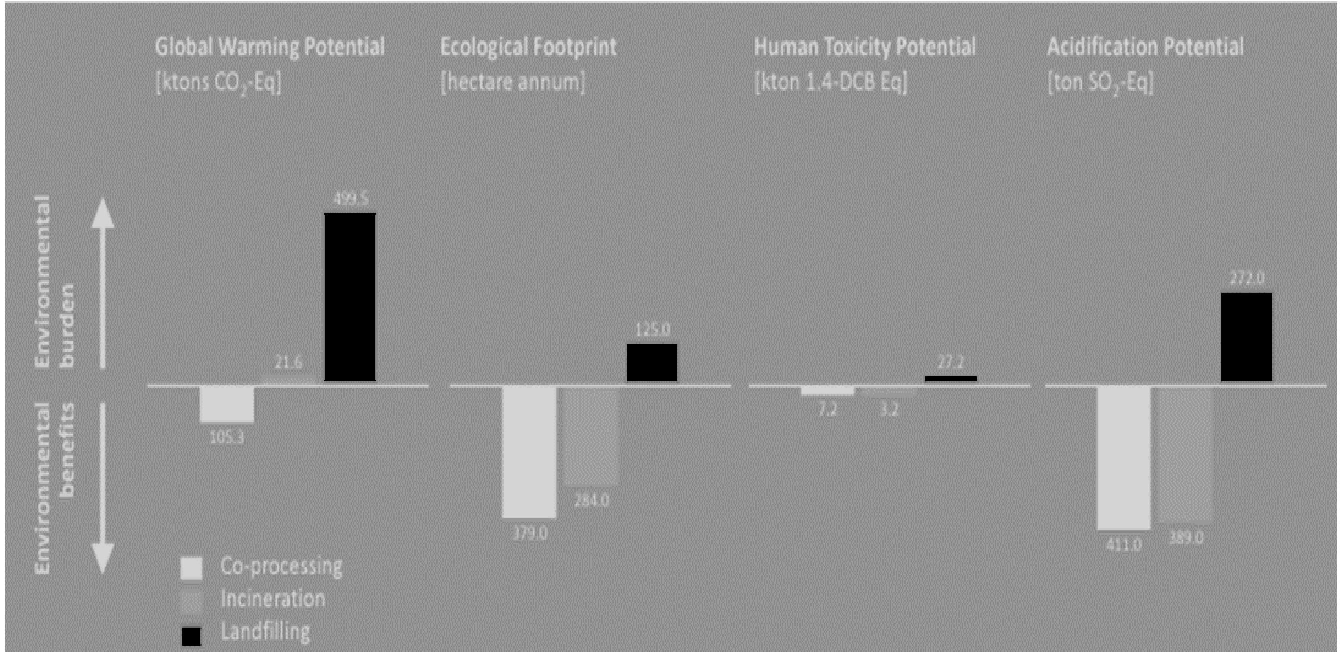


Co-Processing

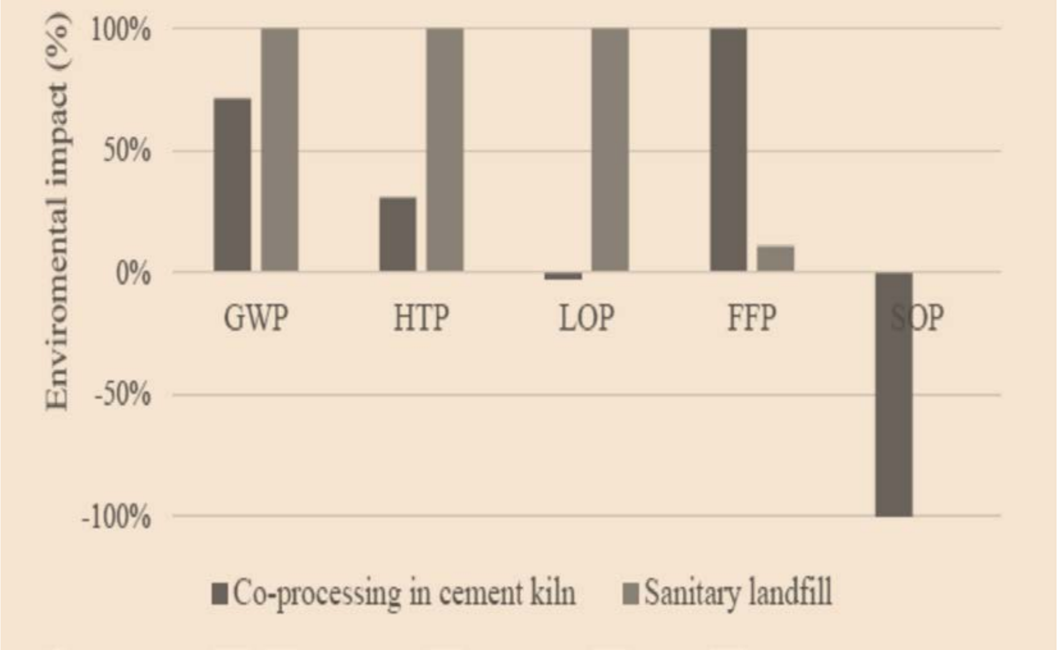
Note: Indian guidelines suggest only non-recyclable plastics may be utilized for co-processing

Relative benefits of co-processing

- Co-processing replaces fossil fuels with a waste stream thereby, reducing GHG emissions
- Longer Residence Time with higher temperatures and excess oxygen
- Ash is completely utilized in making the end product therefore leaves no residue
- Life Cycle Assessment offers the following results when compared with landfilling and incineration



Source: Adapted from Life-Cycle Assessment for treatment of 120,000 tons industrial and municipal solid waste in Slovakia, comparing the Global Warming Potential, Ecological Footprint, Human Toxicity Potential and Acidification Potential of co-processing, incineration and disposal in a sanitary landfill. Ecorec Eastern Europe, 2012
Credits: Geocycle



Yang et al (2020)
Global Warming (GWP), Human toxicity (HTP), Land use occupation (LOP), Fossil resource scarcity (FFP) and Mineral resource (SOP).

Calorific Value vs GHG emissions

Calorific Value for different fuel types

Fuel Type	Coal	Natural Gas	Tires	Waste oil	Plastic	RDF
Calorific Value (GJ/t)	28	38.1	25.1-31.4	25-36	21-49	11.6

CO_2 Emissions from Fuel Sources

Fuel Type	Coal	Natural Gas	Tires	Waste oil	Plastic	RDF
Net Co2 emission factor (Kg Co2/GJ)	96	54.2	85	74	75	45.9

Sources:

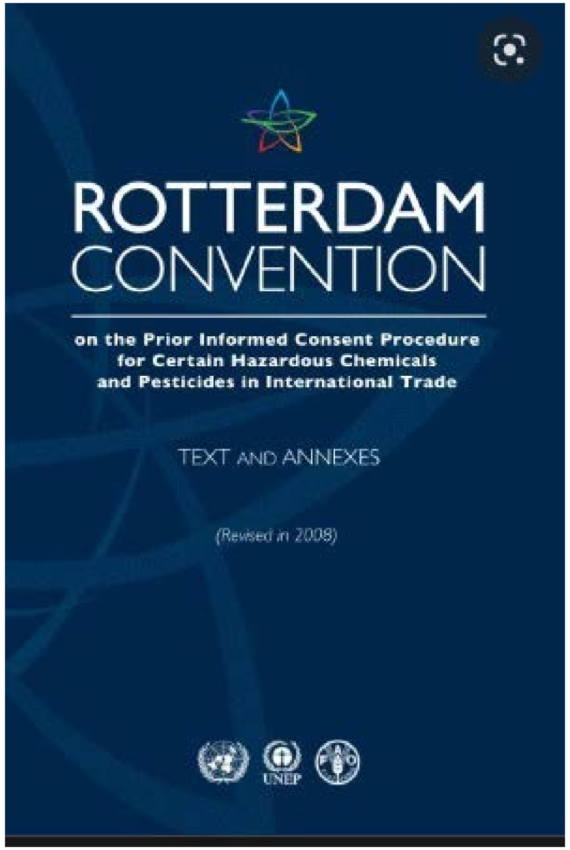
1. Guidelines on Pre- and Co-processing of Waste in Cement Production, GIZ
2. UK Forest Research – Tools and Resources – Calorific Value of Fuels

UNEP Toolkit

- Raw materials/fuels containing chlorides may form PCDD/PCDF at various steps e.g., during cooling phase of the gases, at preheaters or in heat zone.
- Due to the long residence time in kilns and the high temperatures needed to fabricate the product, emissions of PCDD/PCDF are generally low in these processes.
- Detailed investigation has suggested that, provided combustion is good, the main controlling factor is the temperature of the dust collection device in the gas cleaning system,
- Plants equipped with low temperature electrostatic precipitators appear to have well controlled emissions with or without waste fuels.

Sources: UNEP - Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases

UN Conventions



Basel Convention

- The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental treaty on hazardous and other wastes. Basel Convention was negotiated in the late 1980s and entered into force in 1992.
- Basel Convention is based on:
  - International and validated agreements, facilitating sound waste management.
  - Technical Guidelines submission, to promoting regulation and control of sound technologies for waste treatment/ disposal.

Technical Guidelines

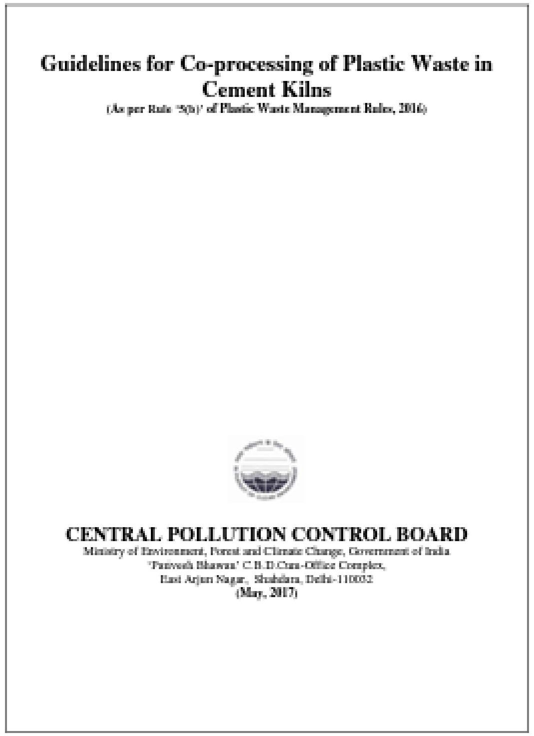
- Co-processing is a sound and recommended technology for hazardous and non-hazardous waste management

- Co-processing is consolidated as recovery operation in the waste management hierarchy,

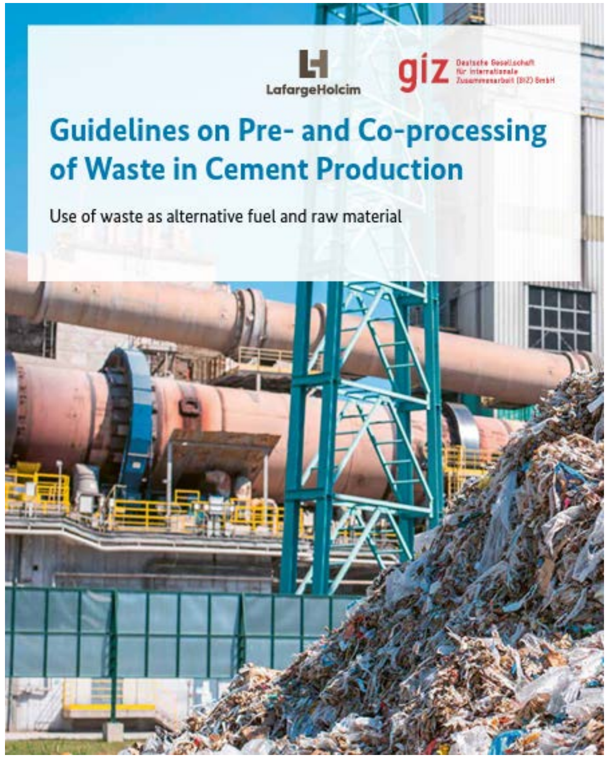
- International and technical criteria / references are now available for local legal frames.

- Minimum standards are now defined, limiting informal and non-compliant players.

International scenario

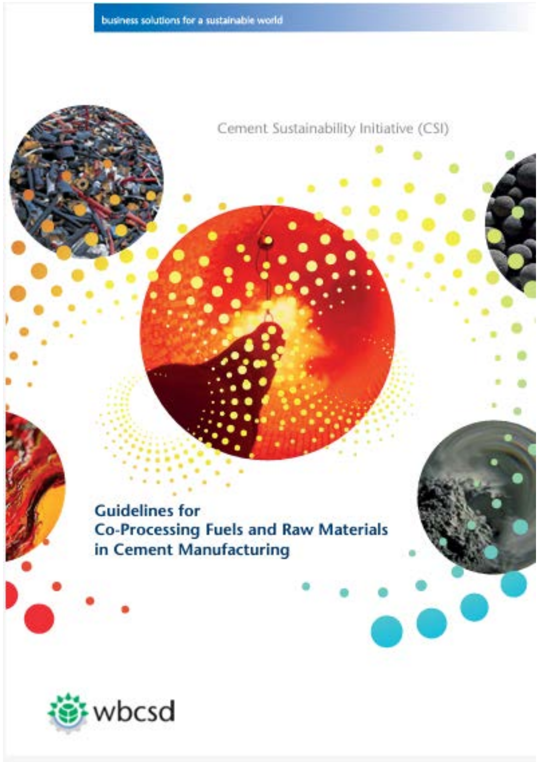


India



GIZ - Lafarge

European Union



WBCSD

Today there are more than 50 countries worldwide, including France, Switzerland, Germany, Japan, having co-processing in cement plants environment & tourism

Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

NATIONAL POLICY ON HIGH TEMPERATURE THERMAL WASTE TREATMENT AND CEMENT KILN ALTERNATIVE FUEL USE

South Africa

Figure 12. List of cement plants that carry out co-processing activities in Malaysia.[[25]][25]

No	State	Name of Premises	Address
1	Pahang	Pahang Cement Sdn. Bhd.	P.O Box 232, Bukit Sagu 4, Kuantan, Pahang
2	Perak	Perak Hanjoong Simen Sdn. Bhd.	2764, Mukim Kg Buaia, Batu 14 Padang Rengas, 33700 Kuala Kangsar, Perak
3	Perak	Tasek Corporation Berhad	No. 5, Persiaran Tasek, 31400 Ipoh, Perak
4	Perak	Associated Pan Malaysia Cement Sdn. Bhd. (formerly LaFarge Kanthan)	13, 1/4 Miles, Jalan Kuala Kangsar, Perak
5	Perak	Hume Cement Sdn Bhd	Lot 300254, 300255, 300256 Mukim Teja, Daerah Kinta, 31610 Gopeng, Perak
6	Perlis	Negeri Sembilan Cement Industries Sdn Bhd	(Perlis Plant) Bukit Keteri, Chuping, Perlis
7	Negeri Sembilan	Negeri Sembilan Cement Industries Sdn. Bhd. (KP)	Lot 3323, Mukim Kepis Kuala Jelai, P.O. Box 22, Bahau, Negeri Sembilan
8	Sarawak	CMS Cement Industries Sdn Bhd	Lot 571, Blok 4, Sentah Segu L/D, Jalan Mambong Off Jalan Puncak Borneo, 93250 Kuching, Sarawak
9	Sarawak	CMS Cement Industries Sdn Bhd	Lot 766, Block 20, Kemena Land District, Kidurong Industrial Estate, 97000 Bintulu, Sarawak

Malaysia

The Embassy of Japan in Indonesia Visited Waste-to-Alternative Fuel Facility at Solusi Bangun Indonesia's Cement Plant in Narogong, West Java

PT Solusi Bangun Indonesia Tbk ("SBI"), a business unit of PT Semen Indonesia (Persero) Tbk ("SIG"), received a visit from the Embassy of Japan in Indonesia and the Japan International Cooperation Agency (JICA) in Narogong Plant, West Java, Friday (25/2). Held by the Minister for Economic Affairs and Development of the Embassy of Japan in Indonesia, Masato Usui and JICA, the visit aims to witness the waste management technology converting wastes into alternative fuels and raw materials operated by SIG.

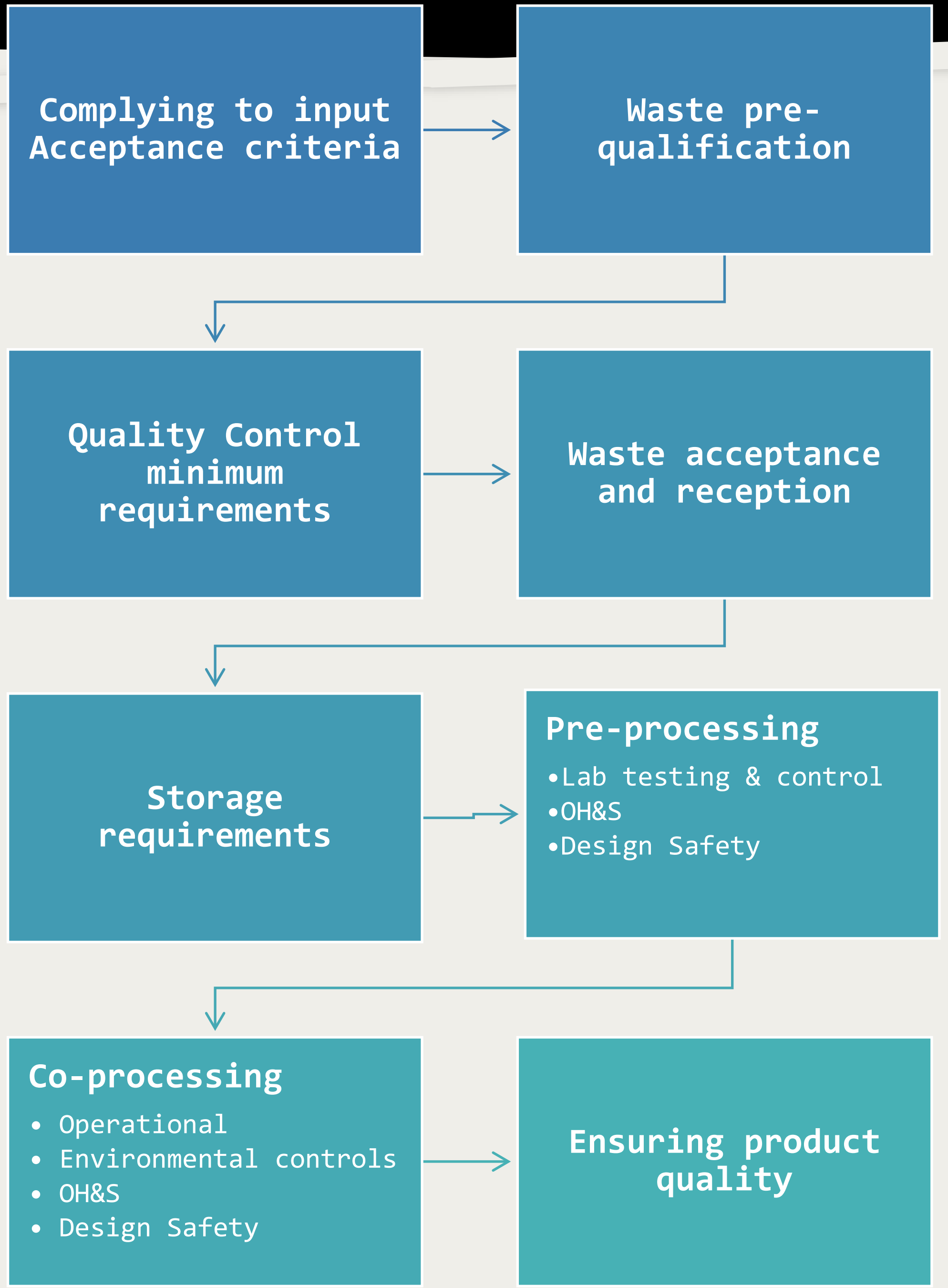
Indonesia

Growing thermal energy substitution

Region	Thermal energy substituted by AF			
	1990	2000	2010	2016
World	2.0%	5.2%	12.1%	16.7%
Europe	2.7%	9.3%	30.4%	44.2%
North America	3.9%	7.3%	12.7%	15.8%
Latin America	2.1%	4.8%	11.8%	14.2%
Asia Oceania	0.7%	3.6%	4.3%	9.0%
Africa Middle East	0.0%	0.0%	2.1%	6.3%
CIS-Countries	0.0%	0.0%	0.6%	1.8%

Source: Cement Sustainability Initiative (CSI), 2016

UN Guidelines on Co-processing



General principles for co-processing of wastes in cement kilns

Respect waste management hierarchy	• Co-processing only where more ecologically and economically robust methods of recovery are not available • Co-processing to be an integrated part of waste management • In line with Basel and Stockholm Conventions and other international environmental agreements
Avoid additional emissions and negative impacts on human health	• Negative effects on environment and health prevented or kept minimum • Air emissions from cement kilns co-processing waste cannot be statistically higher than those not involved in co-processing waste
Quality of cement must remain unchanged	• Product (clinker, cement, concrete) not used as a sink for heavy metals • Product must not have any -ve impacts on environment (e.g. leaching) • Quality of the product must allow for end-of-life recovery
Companies must assure compliance with all laws and regulations	• Environmental and safety compliance records • Personnel, process, & system to protect environment, health, & safety • Capable of controlling inputs to the production process • Maintain good relations with public and other parties
Implementation must consider national circumstances	• Country requirement and needs reflected in regulations and procedures • Build-up of required capacity and institutional arrangements Source: GTZ/Holcim (2006)

General requirements for co-processing of hazardous and other wastes in cement kilns

- Approved EIA and all required national/local licenses, permits, authorisations
- Compliance with all relevant national and local regulations
- Suitable location, technical infrastructure, storage and processing equipment
- Reliable and adequate power and water supply
- Application of BAT for air pollution control, along with continuous monitoring
- Exit gas conditioning/cooling (< 200°C) in the APCD to prevent dioxin formation
- Clear management and organisational structure with unambiguous responsibilities
- An error reporting system (incident preventive and corrective action) for employees
- Qualified and skilled employees to manage wastes and health, safety and environment
- Adequate emergency and safety equipment and procedures, and regular training
- Authorised and licensed collection, transport and handling of hazardous wastes
- Safe and sound receiving, storage and feeding of hazardous wastes

Key Takeaways for co- processing of wastes

- Cement kiln needs to operates on best available techniques and best environmental practice.
- Substances in kiln to be carefully selected and controlled; specifications to be set based on product/process or emission considerations and monitored
- Wastes from trustworthy parties to be accepted, considering integrity throughout the supply chain.
- With provisions for waste quality and waste feeding met, co-processing will not change emissions significantly.
- Consistent long-term supply of waste or AF required to maintain stable conditions during operation
- Alternative fuels to undergo acceptance and inspection procedure before use.
- Necessary to avoid/limit mercury inputs into the kiln system.

Key Takeaways

- Emission monitoring is obligatory in order to demonstrate compliance with existing laws, regulations and agreements.
- Traceability of wastes to be ensured prior to reception by the facility, with deliveries of unsuitable wastes refused.
- Pre-treatment of waste for the purpose of providing a more homogeneous feed and thus more stable combustion conditions may, depending on the nature of the waste-derived fuel, involve drying, shredding, mixing or grinding.
- Consistency in fuel characteristics (both alternative and fossil).
- Keeping adequate excess oxygen to achieve good combustion.
- Waste-derived fuel should never be used during start-up and shutdown

Some challenges

- Sourcing of waste in quantities consistent throughout the year
- Ensuring consistency in the waste composition for processing over a period of time
- High Moisture content, chlorine and heavy metals that could limit acceptance
- Lack of segregation of waste leading to the need to pre-process the waste that may be cost and manpower intensive
- Initial investment cost for setting up pre-processing unit
- Transportation cost from cities to the cement plant
- Lack of sound business model/ mechanism between ULBs and cement plants for cost sharing and ensuring supply of raw material.

Thank you