Life Cycle Analysis of Processes for Resource Recovery from Waste-to-Energy Bottom Ash

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Background

Waste-to-energy (WTE) is a widely accepted municipal solid waste (MSW) management technique, used in over 800 plants world-wide. The major by-product of the combustion of MSW with excess air is incinerator bottom ash (IBA), representing 20-25% of the weight of the MSW combusted. IBA is typically quenched in a water vessel under the discharge end of a moving grate. However, recent developments have shown that dry discharge of bottom ash is possible. For the purposes of this study, six processing scenarios were selected to Life Cycle Analysis (LCA), with data corresponding to innovative IBA recycling plants in various European countries. Inventory data for the IBA processing plants were derived from the industry and the literature.

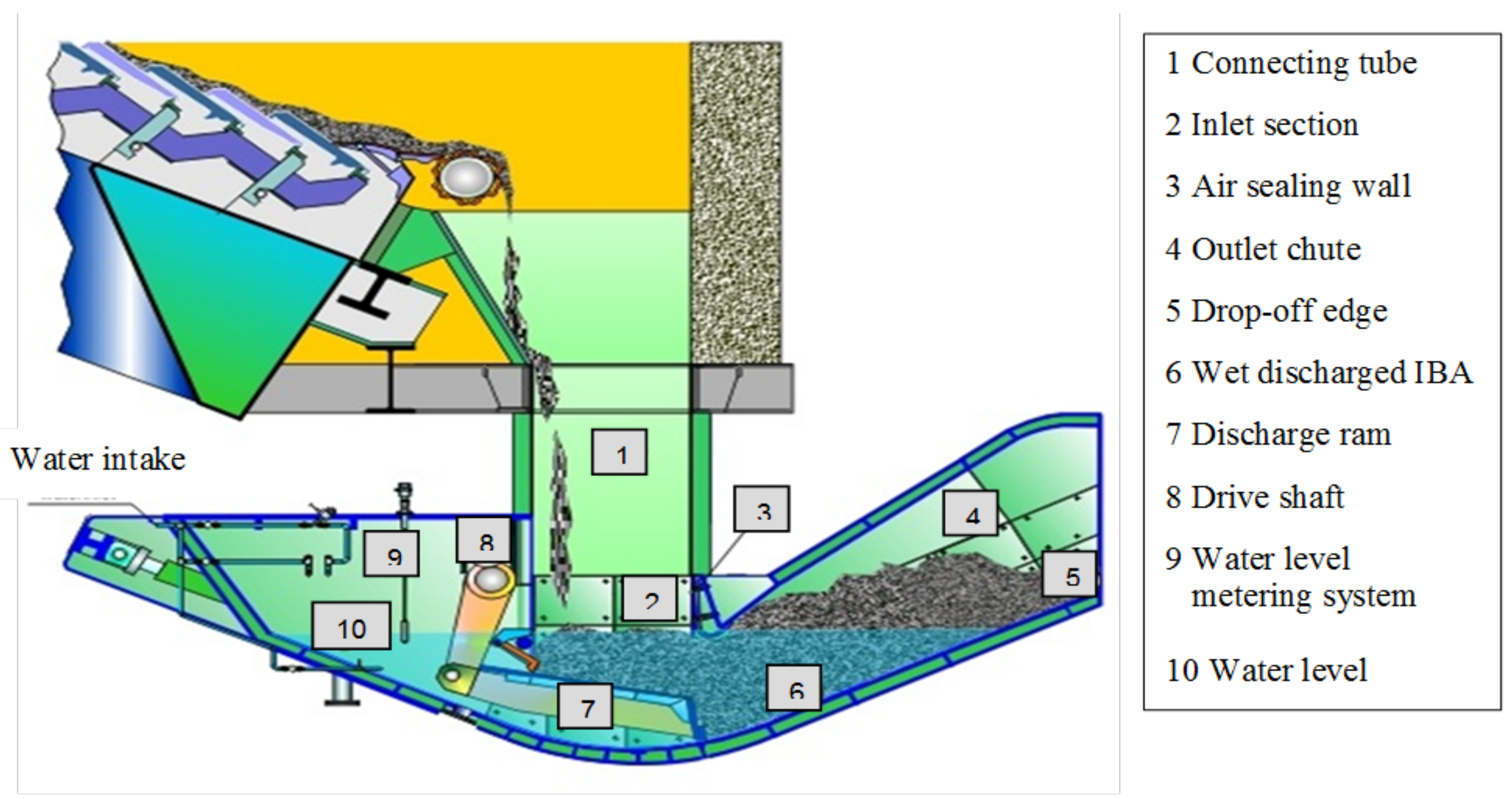

Figure 1. Schematic of Combustion Chamber and Wet Discharge System

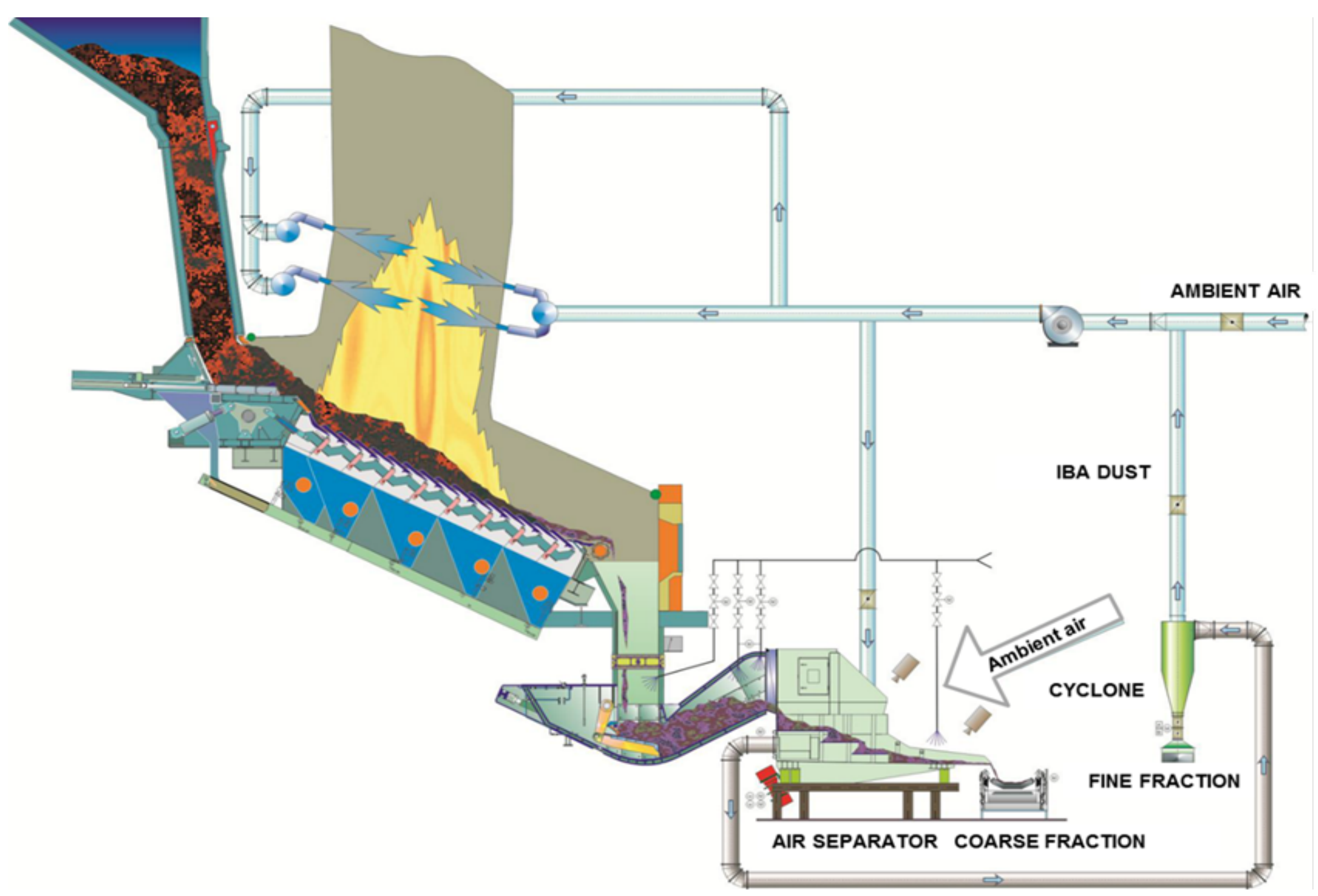

Figure 2. Schematic of Combustion Chamber and Dry Discharge System

Functional unit and scope of the LCA study

Functional Unit: waste management of 1,000 tonnes of wet or dry discharged IBA.

The aim of the research presented in this study is to compare the use of energy and resources, as well as the environmental impacts arising from processing wet and dry discharged IBA using LCA. Six scenarios were chosen with respect to the processes applied to the metals extraction and size separation of IBA mineral aggregates. The system boundaries include the IBA output from the combustion chamber, its either dry or wet discharge, and the subsequent use and disposal stages of the upcycled IBA co-products.

Table 1. Energy and water use for the discharge of IBA, the processing of IBA for the recovery of ferrous and non-ferrous metals and the sorting to different fractions mineral aggregates.

IBA Recycling plant	S1: Conventional Treatment, FR	S2: Conventional treatment plus mineral separation, UK	S3: Advanced wet treatment, NL	S4: Advanced dry treatment, NL	S5: Advanced dry recovery, Zurich, CH	S6: Advanced dry recovery, Monthey, CH	*Units*
Amount	1,000	1,000	1,000	1,000	1,000	1,000	*tonnes*
Discharge System	wet	wet	wet	wet	dry	dry	
Energy use	10	14	22	17	15.2	15.2	*MWh*
Water use	50	50	65	50	0	0	*1,000 m^3*

Findings

- *Discharge system*: The dry discharge system (scenarios S5 and S6) proved more resource and energy efficient.
- *Ferrous and non-ferrous metals:* The most resource efficient systems were the dry discharged systems (S5 and S6), since agglomerations occurring from wet discharge system is eliminated.
- *Coarse and medium mineral fraction*: Landfilling of the coarse and medium IBA fraction leads to multiple environmental burdens (scenarios S1, S5 and S6).
- *Fine mineral fraction*: Stabilization and landfilling of the fine IBA fraction (S1, S3 and S5) leads to higher eutrophication and abiotic depletion burden.

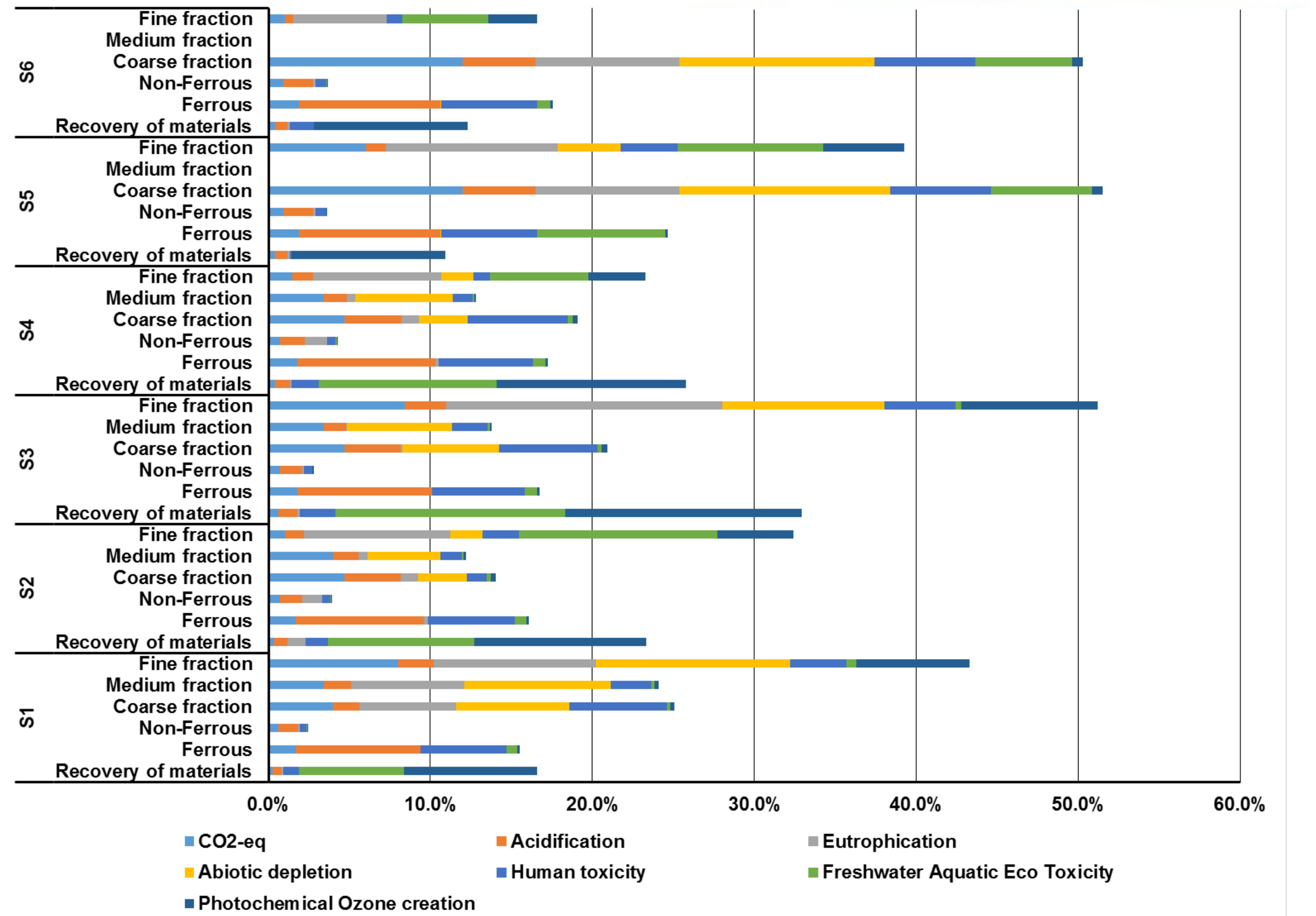

Figure 3. Global warming potential (GWP) based on IPCC 2007 over a 100-year time horizon; acidification (TA), eutrophication, abiotic depletion, human toxicity, ecotoxicity to freshwater and photochemical ozone creation of systems examined. All systems were compared to the natural derived materials, from the point of extraction to their use and disposal, end-of-life. The score of each impact category is expressed as the percentage of the total impact category from all six plants.

Future work

- Continue research on conventional and advanced discharge data.
- Data for secondary market and destination of the unprocessed mineral fraction
- Life cycle cost analysis (LCCA) to estimate the cost of installing improved metal recovery systems.

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Reference

A.C.Bourtsalas, ''PRO CESSING THE PROBLEMATIC FINE FRACTION OF INCINERATOR BOTTOM ASH INTO A RAW MATERIAL FOR MANUFACTURING CERAMICS'', Imperial College London, 2015

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