Evaluation of Best Available Techniques for the Selected Integrated Solid Waste Plant Using Life Cycle Assessment

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The Industrial Emissions Directive (2010/75/EU) addresses the best available techniques (BATs) through BREF documents to be implemented in various processes to achieve the least environmental impact at a minimal cost. Waste management BREF is one of those and describes the numbers of BATs for various waste processing stages. These BATs are just those guided as options, and the determination of the applicable ones for a given plant is a challenge. In this respect, Life Cycle Assessment (LCA) appears to be a valuable tool for assessing the environmental impacts of various BAT implementations within waste management systems. Therefore, in this study, LCA was used to evaluate and identify the most suitable BATs for the selected Closed Integrated Solid Waste Separation, Processing, and Power Generation (ISWP) Plant, in Turkey. The functional unit was selected as 1 ton of municipal solid waste processed. Moreover, the system boundary was defined as gate-to-gate for the entire facility. ReCiPe 2016 (H) was used as an environmental impact assessment method.

The options given in BAT 25 and BAT 34 of Waste Treatment BREF [1], were assessed regarding their environmental impacts on mechanical treatment and desulphurization units of the ISWP Plant, respectively. A cyclone separator, fabric filter, and wet scrubber technologies are indicated in BAT25 to reduce the emissions to air of dust, and of particulate-bound metals, PCDD/F, and dioxin-like PCBs, whereas the use of biofilter, fabric filter, wet scrubber, thermal oxidation, and adsorption are indicated in BAT 34 to reduce the emissions to air of dust, organic compounds, and odorous compounds, including H_2S and NH_3. The scenarios assessed are indicated in Table 1.

Table 1. Scenarios Considered

Scenario	**Processes involved**	**Relevant BAT No***	**The intended aim is to assess**
Scenario 1 (baseline)	MT+ AD + D (w/B) + L	BAT 34b	Existing situation. Also, the effect of using biofilter for desulphurization
Scenario 2	MT + AD + D (w/WS) + L	BAT 34e	Effect of using wet scrubber for desulphurization
Scenario 3	MT + AD + D (w/FF) + L	BAT 34c	Effect of using fabric filter for desulphurization
Scenario 4	MT + AD + D (w/TO) + L	BAT 34d	Effect of using thermal oxidation for desulphurization
Scenario 5	MT + AD + D (w/A) + L	BAT 34a	Effect of using adsorption for desulphurization
Scenario 6	MT (w/C) + AD + D (w/B) + L	BAT 25a & BAT 34b	Effect of using a cyclone in mechanical treatment when biofilter is used for desulphurization
Scenario 7	MT (w/FF) + AD + D (w/B) + L	BAT 25b & BAT 34b	Effect of using fabric filter in mechanical treatment when biofilter is used for desulphurization
Scenario 8	MT (w/WS) + AD + D (w/B) + L	BAT 25c & BAT 34b	Effect of using wet scrubber in mechanical treatment when biofilter is used for desulphurization

**As given in BAT Conclusions of Waste Treatment BREF (Pinasseau et al., 2018)*
A: adsorption; AD: anaerobic digestion; B: biofilter; C: cyclone; D: desulphurization; FF: fabric filter; L: landfilling; MT: mechanical treatment; TO: thermal oxidation; WS: wet scrubbing.

The impact assessment of reducing the dust emission and H_2S concentration via the methods mentioned in both BAT 25 and 34 consistently highlighted the significance of impacts in the global warming human health (GWHH) category. The key indicator responsible for this impact appeared to be electricity input. Although the human non-carcinogenic toxicity (HNCT) category demonstrated the second highest level of influence for each option, the observed impacts were not sufficiently large to make a further elaboration on the relevant responsible key indicator.

The environmental impact of thermal oxidation implemented in line with BAT34 for H_2S removal in desulphurization is remarkably high due to its substantial energy requirement. Conversely, the utilization of fabric filters in the desulphurization unit was determined to have the least environmental impact (Figure 1). When comparing the environmental impacts of the techniques implemented in line with BAT 25 to reduce dust emissions in mechanical treatment, the observed differences in the findings were minimal (Figure 2). Hence, the utilization of wet scrubber, fabric filter, and cyclone separator in mechanical treatment has a minimal impact on the overall environmental impact. In conclusion, the options suggested in BAT34 offer a possibility to reduce the environmental impacts, though BAT25 options do not significantly alter the environmental impacts.

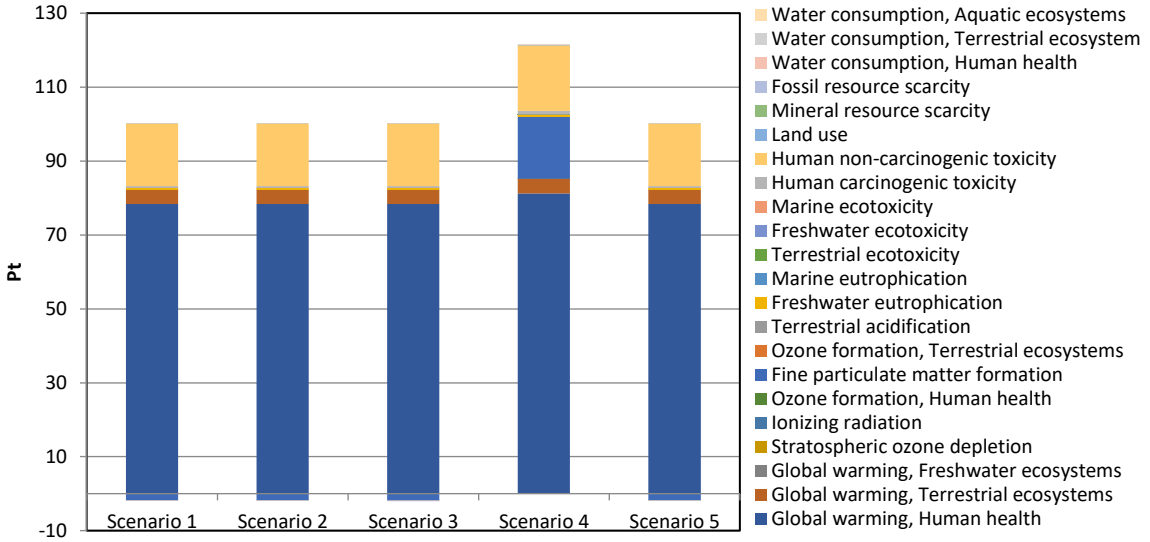

Figure 1. Comparison of BAT 34 options

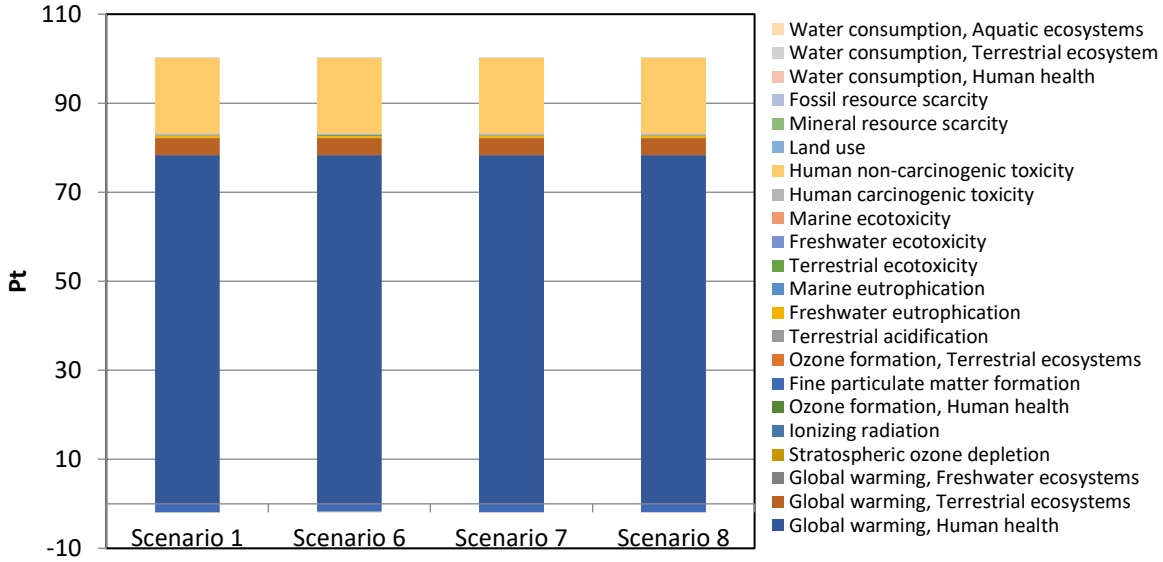

Figure 2. Comparison of BAT 25 options

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References

1. Pinasseau, A., Zerger, B., Roth, J., Canova, M., & Roudier, S. (2018). Best Available Techniques (BAT) Reference Document for Waste Treatment. https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC113018_WT_Bref.pdf.