LIFE CYCLE ASSESSMENT OF WASTE TO ENERGY PLANT WITH AND WITHOUT CARBON DIOXIDE CAPTURE TECHNOLOGY

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Overview

Nowadays the increase of the quality of human life and the economic development have created a huge volume of municipal solid waste (MSW), which has become one of environmental problems. To overcome waste and energy problems at the same time, the Refuse Derived Fuel (RDF) approach has been employed in many European countries (1). The principal advantages of the RDF approach are a reduction of the volume and weight of MSW and a reusable energy output. However, Waste to Energy plants (WtE) contribute to carbon dioxide emissions, thus climate change as consequence. Among different kinds of technologies, carbon capture technology in post-combustion could be applied for decreasing carbon dioxide emissions in atmosphere (2).

Methods

In this work, Life Cycle Assessment (LCA) has been used as analytical tool to evaluate greenhouse gas (GHG) emissions from waste to energy plant with and without post-combustion capture of carbon dioxide (WtE-CC and WtE). This incinerator is assumed to be operated in Italy. According to the literature, LCA consists in a goal and scope definition, inventory analysis, impact assessment and interpretation (3). In the Figure 1 is shown the system boundary for comparative analysis between WtE and WtE-CC plant. Moreover, the chosen functional unit is defined as one kg of RDF.

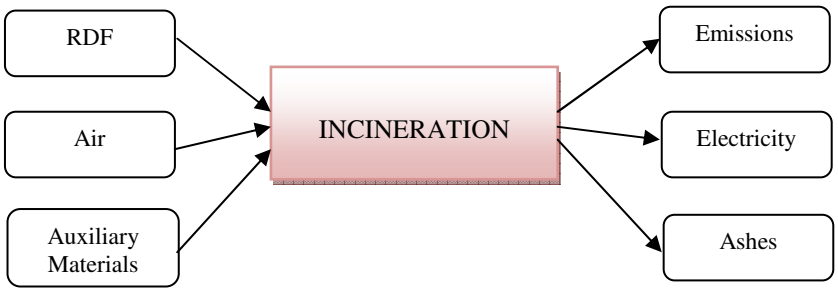

Figure 1. System boundary for comparative LCA between WtE and WtE-CC plant

Results

Material compositions of a typical Italian RDF and theoretical model of elemental chemistry have been used in order to quantify the carbon dioxide emissions. In particular, the incineration of 1 kg of RDF is associated with the production of about 1.67 kg of carbon dioxide. Moreover, CO_2 emissions from incinerated RDF were classified in fossil and biogenic carbon. On the other hand, the proportion of carbon of fossil origin is 53%, and consequently to be considered as climate-relevant. Efficiency of plant for both scenarios were calculated and compared. However, post-combustion CO_2 capture process based on adsorption requires high energy and the resulting efficiency penalty on power cycle. Hence, the efficiency of WtE-CC is lower of nearly 5% than WtE plant.

Conclusions

This study shows the benefit of using LCA methodology to compare GHG emissions between two scenarios and it is useful in determining where the improvements could be made for waste to energy plant. Although the high costs of carbon dioxide capture system, this technology could contribute to obtain carbon negative emissions from waste to energy plants in the near future, according to European goals.

References

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