Abstract

Waste management is a very scattered and complex system made up by different plants and facilities that treat / recover / dispose different types of waste, e.g. Municipal Solid Waste (MSW) or Special Waste, based on the policies adopted in each country and the available technologies. While the management of MSW is the result of public planning, the management of special waste is typically dispersed and depends, for a large extent, on the initiatives of waste producers and private waste management companies. As a result, plants for MSW recovery are relatively large plants equipped with energy recovery facilities, whereas special waste is often incinerated in medium-small plants that feature energy recovery only in very limited cases. Therefore, an initial investigation on the potential integration of Waste to Energy (WtE) facilities with Carbon Capture Utilization and Storage (CCUS) should be focused on MSW and plants devoted to its treatment. Only in European WtE plants, there is a potential capture of 60-70 millions of tonnes of CO\(_2\), and current large-scale projects prove the technical viability of carbon capture technologies in WtE environments.

The paper summarizes the outcome of a study addressing all the opportunities and challenges related to the application of CCUS to the WtE sector. This study is executed by Wood, with the support of LEAP, and commissioned by IEAGHG. The main objective of the work is to carry out an initial overview of this CCS/CCU opportunity before proceeding to more detailed evaluations. The study is based on both literature information available in the public domain and results of surveys with WtE plants owners.

Before evaluating a possible Carbon Capture application to the WtE sector, the study reviews the current status and diffusion of the WtE business and the plants distribution worldwide, focusing on ten representative countries: South Africa, USA, India, Japan, Germany, Italy, The Netherlands, Norway, Australia. The selection considers several parameters: the urbanization level, the branching of the electricity/heat network, the presence of large scale WtE plants, the potential for CCS/CCU applied to WtE plants and the availability of potential destinations for the captured CO\(_2\). The main challenges in this kind of plants, focusing particularly on reliability, are also identified. The link between WtE and CO\(_2\) emissions is then investigated: firstly, the trends and the tools adopted by WtE plants in reducing CO\(_2\) emissions are analyzed; secondly, a lifecycle assessment approach is described and applied to the local contexts of the ten selected countries. The objective is to estimate the CO\(_2\) savings achievable through energy/materials recovery in a WtE plant, potentially leading to negative lifecycle emissions.

The study then focuses on the possible integration of Carbon Capture within WtE facilities, collecting the information relevant to ongoing projects/initiatives aiming at this integration and identifying its potential challenges and opportunities in the design and

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the operation of the plants, based on the available literature. The most interesting aspects identified by this analysis are the energy integration and how the introduction of CO₂ capture alters the energy balance of the WtE plant. There are also risks (related for example to financing, public acceptance, need for technology development) and opportunities (e.g. negative CO₂ emissions, effective energy integration) that may arise from a WtE-CCUS integration.

Considering that the presence of a regulatory framework on WtE and CCS can be an important driver for this kind of applications, a literature research is also carried out to provide an overview of the regulations applicable to the WtE and CCS sectors in the ten selected countries.

Based on the various aspects analyzed throughout the course of the study, a tool is developed to estimate the potential of the CCUS/WtE integration, focusing on the local context of the ten selected counties. This presentation will include the methodology developed in this study, which aims to be a guide for future CCS projects in WtE plants.

**Keywords:** Waste-to-Energy  WtE  CCUS  integration  potential  negative CO₂