To: Gassnova
Ref.: Public report from project 623375
Date: 14.05.2024
Rev.: 1

PROJECT REPORT PLASTICO2 PROJECT: A possible Circular Solution for Plastic Pollution

Plastic pollution

Plastic pollution is one of the most urgent environmental challenges facing the world today. Every year, millions of tons of plastic waste are generated, most of which end up in landfills or the ocean, where they pose a threat to wildlife, ecosystems, and human health. Today, worldwide, we consume 460 million tons of plastic each year, of which only 29 million tons are recycled. Around 80 percent of the plastic waste is believed to be stored in landfills. Plastic is leaking into rivers and seas from landfills and other sources like sewers. It is estimated that between 19 and 23 million tons of plastic entered the ocean in 2016 and predicted to reach around 30 Mt per year in 2030 if no measures are implemented to reduce or mitigate this. Plastic waste also contributes to climate change, as it is derived from oil and releases greenhouse gases when it degrades or is burned. As an example, about 50 % of the CO_2 emission from US WtE plants is estimated to be generated from plastic incineration, corresponding to about 6.6 Mtons CO_2e per year. Accordingly, incineration of larger quantities of plastic containing waste or pure plastics, would cause high equivalent CO_2 emissions, hence such processes must be equipped with CCS.
The PLASTICO2-project concluded that plastic already entered into the ocean will be almost impossible to collect and remove from the environment, so all measures should be taken to keep it from getting there.

Waste-to-Energy and Carbon Capture: A Circular Solution for Plastic Pollution

One possible solution to this problem is to convert plastic waste into energy through a process called waste-to-energy (WtE). WtE plants use various technologies, such as incineration, gasification, or pyrolysis, to transform plastic waste and generate electricity, heat, or fuel. One of the main advantages with WtE is that the process can reduce the volume of the MSW waste by up to 90%, while also providing a renewable source of energy that can replace fossil fuels.
However, WtE alone is not enough to mitigate the climate impact of plastic waste. WtE plants emit carbon dioxide (CO_2). Therefore, it is essential to combine WtE with carbon capture, utilization, and storage (CCUS). CCUS is a set of technologies that can capture CO_2 from WtE plants and either use it for industrial purposes or store it underground in geological formations.
By integrating WtE and CCUS, plastic waste can be transformed from a liability into an asset. WtE and CCUS can create a circular economy, where plastic waste is recycled into valuable products and services, while also reducing greenhouse gas emissions and enhancing energy security. WtE and CCUS can also create new jobs and economic opportunities, especially in regions where landfills are abundant, and geology is suitable for CO_2 storage.
This report provides an overview of the current state and future potential of WtE and CCUS, with emphasis on the US.

AKER CARBON CAPTURE

Technical Aspects

Capturing CO_2 from WtE plants has been, and is, widely considered, and no major obstacles have been identified for this technology. Since plastic already is a major component of the Municipal Solid Waste (MSW) feed to a typical WtE plant, plastic incineration is being practiced widely today. Incineration plants being fed with 100 % plastics are found to have quite similar process-design as a regular WtE plant. Hence, we have not identified any technical showstoppers for burning more plastic in a WtE plant in combination with capturing the CO_2. The higher burning value of plastic compared to general solid waste provides increased energy production from a WtE plant (with similar mass feed rate). Consequently, these plants will also be releasing more CO_2 – which will need to be handled in a capture plant.

Plastic incineration in combination with CCS could contribute substantially to reduce plastic pollution into the environment, while also producing energy for the grid or district heating from the surplus energy in the combustion process. Even if the CCS project is energy intensive, especially due to the amine solvent recovery, the process will be self-sufficient with energy by the surplus energy from the combustion process.

The project concludes that carving or mining plastics from landfills will be very challenging, since it requires special equipment, exposure of gases and costs and potentially increased environmental emissions. Energy production using waste from landfills is also an order of magnitude less than from a more traditional WtE plant. So, when CO_2 is captured from WtE plants with additional plastic in the incineration process, WtE plants are considered as the most attractive candidates for this concept.

Infrastructure and requirements

To obtain the lowest overall cost of a complete plastic handling value chain consisting of collection – preprocessing – incineration (as a part of MSW or as pure plastic) – carbon capture – and storage, a prerequisite is proximity to the storage site. In this project we have focused on the US market, because in the US there are already CO_2 pipelines in operation, and more are being planned, and there are on- and offshore saline aquifers and depleted oil and gas fields available for storage. Accordingly, it has been assessed to which degree available WtE plants are in the neighborhood of potential CO_2 sinks. From an overall perspective it seems that the southeast area in the US, around the Gulf of Mexico, is the most attractive until further infrastructure is developed. The estimated amount of plastic that could potentially be kept out of the ocean from applying WtE with CCS in the US alone depends on several factors. However, using an estimate stating the US is emitting about 43 Mtons of plastic per year, 10 % of this, 4.3 Mtons/y of reduced plastic would be kept out of the oceans. Incineration of this plastic would generate about 10 Mtons per year of CO_2. This again would correspond to 5 – 10 big scale CCS units.

Further work

To obtain a better understanding of the feasibility, and the financial aspects of the concept, our recommendation is to investigate a real site case. The following conditions must then be considered:

- Process simulations of real data
- WtE CAPEX & OPEX
- Costs for CCS plant

- Efficiency of steam turbine and accordingly electricity sold (lost) to grid.
- Distance and conditions for delivery of CO_2 to storage.
- Storage costs
- Compensation for plastic disposal and potential penalty costs for disposal
- IRA CO_2 compensation