Climate action potential in waste incineration plants

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Over the coming decades, our economy and society will need to dramatically reduce greenhouse gas emissions as called for in the Paris Agreement. But even a future low-carbon economy will emit some greenhouse gases, such as in the manufacture of cement, steel, in livestock and crop farming, and in the chemical and pharmaceutical

industries. To meet climate targets, these emissions need to be offset. Doing so requires "negative emissions" technologies, by means of which CO_2 is removed from the atmosphere and permanently stored in underground repositories.

Researchers at ETH Zurich have now calculated the potential of one of these technologies for Europe: the combination of energy extraction from biomass with the capture and storage of CO_2, or bioenergy with carbon capture and storage (BECCS) as it is known. The calculations revealed that if BECCS were exploited to its full potential, it would reduce carbon emissions in Europe by 200 million tonnes per year. This represents 5% of European emissions in 2018 and a substantial proportion of the 7.5 billion tonnes of CO_2 that Europe must cumulatively save by 2050 to reach its climate targets. As the authors of the study also point out, however, fully exploiting the calculated potential of BECCS will be challenging in practice.

Technology ready for action

BECCS involves capturing CO_2 at the point sources where it is produced from biological material. In Europe, companies in the pulp and paper industry offer the greatest potential. Other sectors with potential are waste incineration plants (where around half the waste is from biomass), combined heat and power plants that run on wood, and biogas plants that use compostable municipal waste or plant and animal byproducts of food production that are not suitable for eating. Further sources are wastewater treatment plants and livestock manure.

"The technology for capturing carbon dioxide at such point sources is ready to go," explains Marco Mazzotti, Professor at the Institute of Energy and Process Engineering and head of the study. The carbon would then have to be transported to storage locations via a network yet to be created—in pipelines, for instance. "This is a major challenge,"

says Lorenzo Rosa, scientist in Mazzotti's group and lead author of the study. After all, CO_2 is produced unevenly across Europe. Suitable storage sites are now present only in a few places, far from the CO_2 point sources, such as underneath the seabed of the North Sea. However, this challenge is solvable if such a transport network were to be built up as quickly as possible, says Rosa.

Paper industry

As the calculations of the ETH researchers revealed, the potential of BECCS varies greatly from country to country. At one extreme is Sweden, which has a strong pulp and paper industry. By using BECCS, Sweden could capture almost three times as much carbon dioxide from biomass (and thus atmospheric origin) as it emits from fossil fuels today. "If Sweden were to exploit its full BECCS potential, it could trade emission certificates and thus offset emissions in other countries," says Rosa. Finland and Estonia could reduce their CO_2 emissions by half, also possible thanks to a strong pulp and paper industry. In many other European countries, the potential is lower, with emissions reductions of around 5% or less.

For their calculations, the ETH scientists took into account only biomass that arises as a byproduct of industry or agriculture or as waste. They deliberately factored out crops grown for the primary purpose of energy production, a practice that is more widespread in other regions of the world than in Europe. Because such farming is in direct competition with food crops, it is not considered very sustainable. "With global food demand expected to double by 2050, there is a pressing need to develop BECCS technologies that do not rely on purpose-grown bio-energy plantations," says Rosa.

Waste as raw material

In Switzerland, the BECCS potential is about 6%. Waste incineration plants could make up a large portion of this total. "In many other regions of Europe, by contrast, this potential lies idle, as waste is dumped unused in landfills," says ETH Professor Mazzotti.

Waste incineration plants already fulfil three important functions today: They dispose of waste; they recycle raw materials as far as possible; and they generate district heating and electricity. "Now, a fourth function is being added: As significant negative emissions facilities, waste incineration plants can help reduce the carbon footprint of our society," says Mazzotti. At present, this potential is going untapped. For the most part, no carbon dioxide is being captured yet in paper, incineration or biogas plants. In the opinion of the ETH researchers, we should start doing so as soon as possible.

More information: Lorenzo Rosa et al, Assessment of carbon dioxide removal potential via BECCS in a carbon-neutral Europe, *Energy & Environmental Science* (2021). DOI: 10.1039/D1EE00642H

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