BIOWASTE TO BIOCHAR: HYDROTHERMAL CARBONISATION & HIGH TEMPERATURE TORREFACTION OF FOOD WASTE ANAEROBIC DIGESTATE

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Biochar can potentially contribute as a Greenhouse Gas Removal (GGR) technology to achieve UK's net zero emission target by 2050[1], but risks being constrained by the availability of conventional feedstocks such as wood. Biomass wastes which are less attractive in energy applications, particularly anaerobic digestate, can extend the scale of biochar deployment. Application of stable biochar in the soil is capable of achieving a long-term carbon storage with potential co-benefits for improving the soil quality[2].

Anaerobic digestion (AD) plants treat numerous feedstocks including the current input of around 30% is from food waste. In 2019, over 4 million tonnes of food waste were treated in the operational 579 AD plants[3]. Future growth in the sector will be driven by food waste management, where AD is viewed as an environmentally favourable treatment method for unavoidable food waste. Our analyses indicate the biochar production from food waste digestate achieving a substantial net greenhouse gas (GHG) removals of approximately 1.6 t-CO_2eq.t-biochar^{-1}. Transport distance and soil effects are uncertain but are estimated to have a small impact on GHG emissions, highlighting that the majority of emissions reductions are from the physical storage of carbon in biochar (1.9 t-CO_2eq.t-biochar-1). The use of 50% of UK's projected available food waste digestate by 2030 can sequester around 85 kt-CO_2eq p.a, requiring 28 individual 20 kt p.a biochar production facilities. Commercial biochar production from food waste digestate is able to provide cost-effective GHG removals of less than £100 t-CO2-1 avoided. Other wet wastes such as green waste will command a lower gate fee resulting in higher costs of avoiding CO_2. Sensitivity analysis demonstrates the heavy influence of the gate fee and its importance for biochar process establishment. This work considers a highly promising opportunity in solving a waste disposal burden and simultaneously removing atmospheric GHGs. Multiple sources of biochar will be needed to make significant contributions to the UK's GGR target.

The biochar will be produced at a demonstration facility at the CPL site in Immingham, UK by combining hydrothermal carbonization (HTC) with high temperature torrefaction (HTT) at temperatures of ca. 700°C, to char the biocoal produced by HTC of AD fibre provided by STGP. This will obtain very stable biochar with atomic H/C ratios <0.5 and stable polyaromatic carbon (SPAC)[4] contents of over 90%. Further, the biochar produced will satisfy the voluntary European Biochar Certificate (EBC) environmental standard for biochar and have good adsorptive properties for moisture and nutrient retention. It constitutes a highly promising opportunity in solving a waste disposal burden and simultaneously removing atmospheric GHGs.

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