PhD in ENERGETICS

Research Title: Biochar production and use for airports and airlines

Funded by	DENERG (HORIZON 2020 – TULIPS project)

Supervisor	Prof. David Chiaramonti

Context of the research activity	Achieving carbon emissions neutrality is central concern for airports, especially in light of the increased public focus on carbon emissions from aviation in recent years (and the pre-pandemic steady growth of passengers). Through various accreditation schemes many airports have already implemented significant improvements of their carbon budget. However, airport roadmaps will include carbon "offsetting" practice toward carbon neutrality or even carbon sequestration, most usually involving non-local solutions. Conversely, carbon storage in soil on airport land can enable airports to lower their carbon budget based around entirely local practice, often bringing various other positive side effects – not least possible improvements in public perception of the airport's green credentials – due to the nature-based solutions implemented. The potential of marginal lands in Airport areas has also been identified as a key area to address in a recent study by DG Energy. One particularly significant example of a potential nature-based solution is the use of biochar to airport land soil. Biochar production will be possible through circular recovery of organic materials (Organic Fraction of Municipal Solid Wastes, in agreement with the new EU fertilizer regulation based on Strubias study by EC JRC) and/or residual biomass, possibly produced at the airport, and its conversion into a stable recalcitrant carbonized material. This material will then be incorporated into the soil of airport land, becoming an effective carbon sink. However, the possibility of circularly reusing organic waste and residues requires a better understanding of the thermochemical conversion processes applied to residual streams, including a focus on the inorganic matter in the feedstock, its fate during thermochemical conversion and how the conversion process's settings influence its properties, most notably the leachability carbon and inorganics by rainwater or, on the opposite side of the spectrum, accumulation into soil.

Objectives	With specific focus to the context of airports and circularity, the candidate will carry out an evaluation of the potential recovery of the organic fraction of solid waste collected at the airport and its possible conversion into biochar through slow pyrolysis. He/she will analyze and investigate the main reaction kinetics and the energy balance of slow and/or intermediate pyrolysis processes of residual biomass/organic waste, improving the knowledge about the process impact on energy performances of the value chain, product (char) quality, and advancing the understanding of the effect of process parameters on the leachability or stabilization of mineral matter. This is particularly relevant in light of the circular approach, which prioritizes the recovery of critical raw materials and valuable components, following the "cascading" concept by EU. He/she will provide better insights of the interaction between biochar inorganic matter (type, amount) and both soil and water, with a specific focus on 1) mineral matter retention, and 2) removal of heavy metals from soil. He/she will explore methodologies for generating and accounting offsetting carbon credits from biochar production and deployment: starting from a revision of existing practices, he/she will complement the research work of TULIPS, so to provide EU EU ETS and ICOA-CORSIA obliged stakeholders (Airlines) with a clear route to this new CO_2 offsetting route, or contribute to LCA works applying EU REDII requirements.

Skills and competencies for the development of the activity	The PhD candidate is expected to develop: • Competences on the pyrolysis energy conversion process and the reaction kinetics for biomass and bio-based waste feedstocks • Strong experience and understanding of thermochemical conversion processes and, in particular, of the impact of reactor type/process parameters on expected biochar composition and quality • Competences on biochar effects as soil conditioner and growing media • Knowledge about principles of soil carbon content, carbon stability and carbon accounting systems • High skills in laboratory experimental and analytic activities, with specific focus on inorganic leaching process • Competences on the behaviour of biomass inorganic elements during thermochemical processes