ENERGETICS

DENERG - Sustainable production routes for hard-to-abate industries

Funded By	Dipartimento DENERG

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Context of the research activity	DENERG is involved in many research activities related to the decarbonisation of hard-to-abate transport sector. The DENERG, and the Prof. Chiaramonti team in particular, works to support the green transition by proposing innovative solutions with lower GHG emissions. Hard-to-abate sectors includes transport (e.g. aviation and maritime), as well as industrial sectors such as steel making and cement. One of the main factors influencing the sustainability of the steel making processes is the intensive use of fossil coal as energy and carbon sources: about 200 million tons of coal were consumed in Europe in 2019, before covid pandemic. Of these, around 134 million tons were imported, equal to around 840 million tons of hard coal. To increase the sustainability of steel making, innovative processes and energy integration are key. The PhD candidate will perform system energy modelling of various processes, including the introduction of hydrogen and carbon from innovative, highly sustainable production routes. Together with carbon, hydrogen is in fact crucial for decarbonising the sector. In this broad context, the role of the green hydrogen - produced from a variety of technologies, mostly bio-based – will be investigated to define the potential environmental benefits.

	The first objective of the PhD is the identification of potential alternative production options for supporting the green-transition for the steel-making sector. The PhD will assess and validate the application of residual organic waste, as alternative sources to produce biocoal and coal gases for steel making processes. The activities will focus on the transformation of largely available organic waste streams, among others: sewage sludge, industrial sludge, domestic organic waste, food waste and agricultural waste, by slow pyrolysis, to produce biocoal and pyrolysis gases. The quality of the biocoal obtained from slow pyrolysis of residual streams will be assessed against the standards required for the steel production. Another important aspect to be investigated is the role of renewable hydrogen, produced from various routes. The identified technological portfolio describing the existing and innovative production pathways, is expected to

Objectives	support the further modelling stage. This will have to clearly indicate the feedstock-to-hydrogen value chains, identifying the technological readiness level and, potentially, the commercial readiness level. The PhD have to perform system energy modelling of identified processes, for the introduction of hydrogen and carbon obtained from innovative, highly sustainable production routes. The objective of this part of the PhD is to identify opportunities for highly integrated processes, to lower the overall environmental impact of producing alternatives to fuel the transport sector. Another important objective of the PhD is to investigate the feasibility and techno-economic potential impact of using innovative solutions, in the identified production chains. Finally, the PhD will have to quantify the potential environmental benefits of using green hydrogen, as sustainable molecules for alternative fuels production. The research will contribute to the definition of actions to reduce the impacts of climate change and to the promotion of sustainable development, as a contribution to promoting green recovery and overcoming the effects of the climatic crisis.

Skills and competencies for the development of the activity	The PhD candidate is expected to develop: • Competences on energy conversion process and energy modelling, in particular for biomass and bio-based waste feedstocks. • Sustainability framework for biomass to energy vectors pathways. • Strong experience in understanding the conversion processes. • Competencies about green hydrogen production. • Competencies on environmental LCA. • Other relevant soft skills, such us: o Team working. o Autonomy at work. o Problem solving. o Communication skills. o Basics of project management.