The overall aim of the research proposal entitled *Exploiting chemical modification of coffee waste and lignin: a novel approach for sustainable energy storage systems* (CAFFEINE) is to explore a groundbreaking strategy for transforming coffee waste and lignin into sustainable sources of a new generation of electrodes for energy storage systems. As part of a circular economy approach, this groundbreaking research endeavors to convert WCG into activated carbon for supercapacitors and functionalize lignin for use in metal-ion batteries, mitigating waste disposal and promoting green energy storage. The project's objectives involve optimizing electrode materials from biomass sources, enhancing their electrochemical performance, and creating a hybrid supercapacitor with superior energy and power densities. Our focus involves an in-depth exploration of the critical parameters of waste coffee grounds and lignin, such as surface area, heteroatom doping, and electrical conductivity, that determine their electrochemical performance. This analysis aims not only to establish stringent quality control measures for biomass materials but also to adapt and expand our methodology to encompass various real-world biomass waste streams, thus broadening the scope of our findings and paving the way for a greener energy landscape.

CAFFEINE aims to address the critical scarcity of essential raw materials such as lithium and natural graphite by capitalizing on materials that are abundantly available yet commonly discarded. It pioneers the optimization of waste coffee grounds' transformation into activated carbon, ideal for supercapacitors, while concurrently exploring strategies to functionalize lignin, a byproduct of industries like paper and bioethanol, for use in metal-ion batteries. Ultimately, both materials will be combined into a hybrid device to achieve superior electrochemical performance. This novel approach ingeniously merges two distinct waste sources, tapping into their inherent potential to create high-performance electrodes, not only mitigating waste disposal concerns but also embodying the principles of a circular economy. By leveraging biomass waste materials, this project charts a pioneering path toward sustainable energy solutions, marking a significant stride in advancing eco-friendly and resource-efficient energy technologies with the potential to reshape the energy storage landscape.

This project will offer top-quality multidisciplinary research and knowledge transferring (ToK) encompassing a very wide spectrum of techniques including (1) production of WCG- derived AC *via* carbonization and activation processes, (2) lignin synthesis and chemical functionalization with electrochemically active molecules (3) sophisticated tools for the morphological and multiscale characterization of the functional materials, (4) electrode fabrication, (5) micro- and nanofabrication of energy storage devices, as well as (6) their electrochemical characterization. Such a broad and multidisciplinary project will promote the development of future sustainable energy storage devices featuring state-of-the-art performance.