Smart Transport Electrification for Sustainable Urban Mobility

The objective of this project is to study, model, and optimize trolleybus networks in Italian urban areas. In line with the themes of the National Recovery and Resilience Plan (PNRR - Piano Nazionale di Ripresa e Resilienza), reducing climate-changing emissions is a critical priority, particularly in urban areas. To achieve this goal, the decarbonization of the transport sector is crucial. While significant efforts are being directed towards private transport, public transport also plays a key role and should not be overlooked. Dynamic conductive charging through catenary systems is potentially a zero-emission (excluding indirect emissions) solution, although many of the vehicles currently rely on Internal combustion engines.

The project focuses on trolleybus networks, already established in several metropolises, by addressing technical aspects to enhance their sustainability. To improve system efficiency and optimize energy flows, better integration of these solutions with renewable sources and the existing electric network of the urban area is essential. The project will explore the following technologies: stationary energy storage systems (ESSs) to support the grid during peak demand, renewable energy sources (RESs) to facilitate the shift to greener urban environments, and charging stations for private electric vehicles, promoting a more seamless integration of public and private mobility.

The circuit modelling phase will be crucial to evaluate the improvements introduced into the network. A comprehensive model of the electric traction grid must be devised to account for the substations, the motion of vehicles along the line, and the equipotential bonding system, which contributes to the complexity of the network. Additionally, the project will involve the modelling of vehicles, power electronics devices (required for connecting smart-oriented technologies to the DC grid), ESSs, and RESs. The sizing of these systems will also be addressed by developing key performance parameters to allow comparison among different solutions. Energy management algorithms will be crucial to increase the efficiency of the system and better integrate the different elements. The validation of these algorithms will be achieved by the real-time emulation of the network, based on the models developed in the first stage of the project.