VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Boud Verbrugge**

The public defense will take place on **Wednesday 11th October 2023 at 4:00pm** in the **Green Room** (Building **U-Residence,** VUB Main Campus)

To join the digital defense, please click here
Meeting ID: 394 062 944 181
Passcode: nfPDLe

DESIGN OPTIMIZATION AND INTELLIGENT CONTROL STRATEGIES FOR ELECTRIC BUS DEPOT CHARGING SYSTEMS

BOARD OF EXAMINERS

Prof. dr. ir. Svend Bram

Prof. dr. ir. Wendy Meulebroeck

Prof. dr. ir. Valéry Ann Jacobs

Prof. dr. ir. Philippe Lataire

Prof. dr. ir. Jean-Luc Thomas

Dr. ir. Laurent Devroey

PROMOTORS

Prof. dr. ir. Omar Hegazy

Dr. ir. Thomas Geury

VRIJE UNIVERSITEIT BRUSSEL

Abstract of the PhD research

Driven by the goal of the European Commission to significantly reduce the greenhouse gas emissions from the transport sector in the coming years, public transport operators are introducing battery electric buses in cities because of their positive impact on air quality and climate change. However, because of their high charging power requirements, an additional stress will be imposed on the existing electricity grid when larger bus fleets will make their appearance. Bus depots are one of the key locations that must be redesigned to enable a faster transition to electric buses. As a result, the main focus of this PhD research is to provide innovative and cost-effective design and control solutions to optimize the charging process of battery electric buses in a depot and reduce their impact on the electricity grid.

To this end, a smart high-level real-time scheduling and optimization algorithm with vehicle-to-everything functionalities is developed. It provides an optimal charging plan for each bus in the depot by taking into account charging requirements and grid restrictions. The algorithm also allows to investigate the possible advantages of bidirectional charging compared to only unidirectional charging. Additionally, a reliability assessment framework is used to examine the effect of smart and bidirectional charging on the lifetime of depot charging systems. Furthermore, since the next-generation of charging infrastructure will have a modular architecture, a current allocation strategy is presented that optimizes the operation of the modules and reduces the power losses. Finally, the economic and technical benefits of integrating photovoltaic panels and an optimally sized energy storage system with a bus depot are analysed. An energy management strategy controlling the power flow between the different subsystems of this depot microgrid is proposed to reduce the operational costs. To verify the performance of the developed intelligent control strategies in real-time, they are experimentally validated with down-scaled hardware-in-the-loop test setups including existing charging systems.