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 **Gilles Van Kriekinge**

The public defense will take place on **Wednesday 16th October 2024 at 4:00 pm** in room **I.0.02** (Building I, VUB Main Campus)

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OPTIMAL SCHEDULING OF ELECTRIC VEHICLES CHARGING FOR LOCAL ENERGY SYSTEMS

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Abstract of the PhD research

Climate change is a major issue whose effects on the environment and the society can be mitigated by reducing drastically the CO2 emissions of human activities. Since the transport and the energy sector account for 24% and 41% of the CO2 emissions respectively, both sectors must undergo substantial changes in the coming years. Renewable energy sources (RES) and electric vehicles (EV) emerge as two promising solutions for the reduction of greenhouse gas emissions. Such solutions are often organized as local energy systems (LES) where (renewable) producers (solar, wind) and consumers (buildings, electric vehicles) are connected to single grid connection. However, unsupervised integration of such assets in a LES can result to suboptimal operation. Therefore, it is of paramount importance to correctly prepare and execute the integration of these into LES.

This PhD research focuses on developing new techniques to understand and to enhance the integration of RES and EVs into LES, with a particular focus on charging infrastructure. To achieve this, a novel data-driven methodology is presented to simulate charging session. The methodology consists of extracting EV user types from historical charging sessions data,
followed by their characterization using specific probability density functions (PDF). Based on the PDFs, charging sessions can be generated for local energy systems based on a certain fleet constitution. The results show that the methodology effectively captures the stochastic nature of the drivers' charging behavior in time, frequency and energy demand for different types of drivers, while respecting aggregated charging demand.

Following this, a state-of-the-art energy management system (EMS) is developed to control, in an intelligent manner, the charging process of the EVs in the LES. The novelties lie in the application of such EMS for both uni-directional and bi-directional charging of EVs, featuring a new multi-objective function and the use of an advance forecasting technique for building load consumption. The EMS undergoes testing in a simulation environment as well as in a real-world environment. The simulation environment enables to assess the EMS across multiple use cases and sensitivity analysis. The real-world environment allows to validate the performances of the EMS as well as to assess external human, technical and environmental factors that could impact the performances of the EMS.