Titre Thèse (subject)	Using Electric Vehicles as Distributed Energy Storage Systems: A Digital Twin Based Approach	
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Financement prévu ☐	Contrat Doctoral Etablissement **X** Région ☐ – Autre **X** Contrat de recherche ☐ Préciser :	ULille ☐ UPHF ☐ Centrale Lille ☐ UGE ☐ IMT ☐ Autre ☐
Financement acquis ? ☐	Contrat Doctoral Etablissement **X** Région ☐ – Autre ☐ Contrat de recherche ☐ Préciser :	ULille ☐ UPHF ☐ Centrale Lille **X** UGE ☐ IMT ☐ Autre ☐

Résumé du sujet (abstract):
Bulk Energy Storage Systems (ESSs) are needed for optimal utilisation of renewable energy to achieve improved grid resilience, reduced grid maintenance and operation costs, and minimised environment impact. However, these storage units locate far from the end customer and the required land space is scarce and expensive. Thus, the key to cost-effective energy storage is to place it at the very edge of the grid where it can optimise generation, transmission, and distribution.
By 2050, around 14 TWh of electric vehicle (EV) batteries could be available to provide grid services, compared to just 9 TWh of stationary batteries. Idle vehicles can store energy through grid-to-vehicle (G2V) technologies to achieve optimal utilisation of Distributed Generation (DG). To achieve this, the infrastructures must be managed effectively and intelligently through new technologies such as digital twin (DT).
This requires comprehensive monitoring and evaluation to anticipate the factors that influence network dynamic operation. This project would investigate how digitisation would optimise the vehicle-to-grid (V2G) process in conjunction with distribution grid constraints, the availability of local renewable energy resources and customers' preferences.
Furthermore, a durable and reliable V2G-based demand response system would be developed by implementing a digital twin based energy management scheme, which accurately calculates the mobile storage capacity in real-time, and use it to achieve a balance between the local generation and local demand.

Joint PhD with Coventry University, UK (C-ALPS: Centre for Advanced Low Carbon Propulsion Systems) with a double PhD degree

Objectives :
DT based V2G concept is in its infancy and requires a significant amount of research. This PhD project would help to evolve this concept by addressing the following main questions:
(1) Could the digitalization technique improve the grid integration of EV and V2G functions?
(2) Could digitalization increase the self-consumption of local RES ?
(3) Could digitalization provide enhanced utilization of existing and new electrical infrastructure?
This project will demonstrate how digitization would optimise the V2G process in conjunction with distribution grid constraints, the availability of local renewable energy resources and customers' preferences. In line with the above research questions, this proposal sets out three main objectives:
- Develop a digital replica of a city distribution grid by implementing an edge deployed twin for each grid entity. The proposed twin models should be able to successfully replicate the performance of their physical counterpart.
- Develop a durable and reliable V2G based demand response system by implementing a DT based SSC method. The proposed scheme must be able to accurately calculate the mobile storage capacity in real-time and use it to achieve a balance between the local RES generation and local EV demand.
- Develop an experimental testbed to validate the operation of the proposed DT based V2G control and proof that the performance of EV based ancillary services can be improved by adopting DT technique.

To reduce the project risk and to ease project technical management, the project will be divided into three Work Packages (WPs) as follows:

Work program

- WP1 – Development of edge deployed DT models

A model-based DT would be developed for each grid entity and would be implemented using National Instrument PXI. The models would interact in real-time with inputs and outputs of their physical counterpart. By using physics-based simulation in conjunction with analytics, the proposed twin models would be able to 100 percent predict the product (EV and DG) future performance. The models would exhibit customisable constraints on max charging/discharging power to allow modelling of specific or generic V2G units and max/min storage capacity of EVs.
Deliverables: DT models of EV, DGs and distribution grid

- WP2 – Implementation of a DT based SSC method

A DT based SSC method would be proposed by incorporating the details on EV charging and discharging patterns, life estimation of battery and power electronic, customer preference, planned grid maintenance etc. By considering these factors, an enhanced demand response scheme would be proposed to improve the system performance. The proposed scheme would comply with ER G99 regulations for LV connections. In addition, DT (mirror image of the plant) will be used as a non-production testbed to validate new control schemes in a risk-free environment. This would permit the network operator to study the performance of the new control system without disrupting the plant operation.
Deliverables: DT based SSC model and demand controller, risk-free control tuning method

- WP3 – Development of an experimental testbed

A power hardware-in-the-loop (PHIL) based testbed will be used to validate the performance of proposed DT based control systems and communication protocols. Furthermore, WP 1 and 2 serves as direct input for WP 3. The testbed consists of a photovoltaic (PV) inverter, a Typhoon HIL202 connected grid emulator and lithium-ion based energy storage systems (ESSs). A simple distribution grid would be modelled using Typhoon simulator. A dSPACE MicroLab Box would be used to establish communication between the DTs of EVs, PV inverter and the grid. A Supervisory Control and Data Acquisition (SCADA) system would be implemented using dSPACE ControlDesk software to monitor the performance of each DT. All equipment is already available within C-ALPS power electronics laboratory.
Deliverables: DT embedded PHIL testbed with decentralised energy resources

Skills

The PhD-position's main objective is to qualify for work in research positions, a past experience related to research activities will be appreciated.
The candidate must have a solid training in power electrical engineering, power electronics and power systems.
The candidate must have the ability to work independently and to well organize himself.
Good communication and writing skills in English are mandatory. The following tests can be used as such documentation: TOEFL, IELTS or Cambridge Certificate in Advanced English (CAE) or Cambridge Certificate of Proficiency in English (CPE). Minimum scores are:

- TOEFL: 600 (paper-based test), 92 (Internet-based test).
- IELTS: 6.5, with no section lower than 5.5 (only Academic IELTS test accepted).
- CAE/CPE: grade B or A.
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We offer :

- exciting and stimulating tasks in a strong international academic environment (France and UK).
- an open and inclusive work environment with dedicated colleagues and a high level hardware equipement.

The application must include:

- CV, certificates and diplomas
- Academic works - published or unpublished - that you would like to be considered in the assessment
- Name and email address of two referees