Master Internship Project

Project title: **Power Management in Ship-board Maritime Micro-grids – Case of an electric Ferry**

Project description :

In recent years, the transportation sector has made sustained efforts to reduce greenhouse gas (GHG) emissions. These emissions mainly come from ships and port activities. In this context, the International Maritime Organization (IMO) recommends reducing GHG emissions from maritime transport by almost 50% by 2050. The main action consists of encouraging ships to reduce the use of energy fuels with high carbon footprint in favor of less polluting fuels and alternative energy sources. These efforts also involve the integration of new energy storage technologies. Currently, the electrification is mainly aimed at ferries and small passenger and short sea vessels. The transition to ferry boats powered by clean energy sources combined with storage systems is increasingly facilitated thanks to technological advances in energy conversion and storage systems. The interconnection of different sources and energy storage systems, as well as electrical loads of different natures (electric propulsion, hotel loads, etc.) represents in itself a “Mobile” electrical Micro-grid.

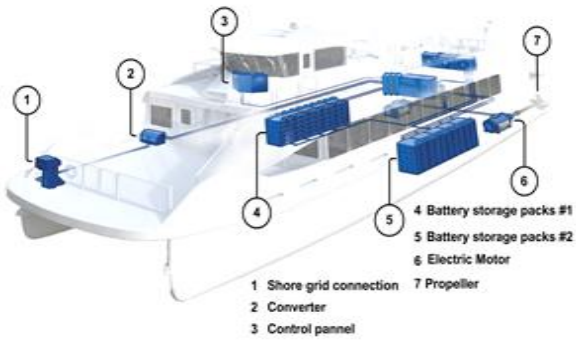

Fig. 1. Typical configuration of an electric ferry boat

These Micro-grids must be controlled locally via the conversion interfaces in such a way to ensure the desired electrical characteristics (voltage amplitude, frequency, etc.) and also in such a way to ensure the management of power flows on-board and good exploitation of energy resources. Furthermore, unlike “Stationary” Micro-grid applications where connection to the electrical utility grid is always possible to compensate for the intermittency of energy sources and variation in loads, “Mobile” Micro-grids, namely Ship-board Microgrids are isolated and can experience significant load fluctuations with limited power. Control and management strategies are necessary to maintain electrical voltage within acceptable limits and to ensure management of energy reserves even under fluctuating load and navigation conditions.

In this internship, the objective is to develop a power flow control and management strategy (primary and secondary control) for a DC type Ship-board Micro-grid powered by battery packs and clean energy sources (fuel cell type , etc.). The objective is to maintain reliable power supply and to optimize the participation/operation of battery storage systems and energy sources on board.

Work organization :

The work that will be carried out in this internship will be structured as follows:

- Study the context linked to electrification and the integration of clean energy sources in boats. The study will categorize the different types of ship applications according to use, power levels/voltages, and according to the configuration of the electrical grids on-board.
- Do a literature search on the different Microgrid architectures and their control – The work will focus on the primary and secondary control of Microgrids. A comparison of the different power flow management techniques will also be carried out.
- After having defined the structure of the on-board Microgrid to be studied, the objective will be to model and simulate the system on Matlab/Simulink.
- Implementation of the planned power flow control and management strategy and analysis of the simulation results obtained.
- Promote the work carried out and the results obtained by writing a scientific communication (06 pages). The final report will be written throughout the internship.

Terms:

- Period envisioned for the internship: **February 2024 à July 2024**
- Main internship location:**Laboratoire IREENA** (https://ireena.univ-nantes.fr/)
- Targeted student specialty(s):EEA - Electronique, Electrotechnique, et Automatique
- Type of Internship:**Master 2**
- Funding: Grant as part of the **CARGO Cluster** (allowance according to the scale provided for by the Education Code)

Candidacy :

Please send your application (CV with references, and cover letter) to **Abdelhakim Saim** and **Azeddine Houari** . Do not hesitate to contact us if you need more information.

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References:

[1] Aboelezz , AM, Sedhom , BE, El- Saadawi , MM, Eladl , AA, & Siano , P. (2023). State-of-the-Art Review on Shipboard Microgrids: Architecture, Control, Management, Protection, and Future Perspectives. Smart Cities, 6(3), 1435-1484. https://doi.org/10.3390/smartcities6030069

[2] Zeng, Y., Zhang, Q., Liu, Y., Zhuang, X., Lv , X., & Wang, H. (2022). An improved distributed secondary control strategy for battery storage system in DC shipboard microgrid. IEEE Transactions on Industry Applications, 58(3), 4062-4075. https://doi.org/10.1109/TIA.2022.3153755

[3] Saim , A., Houari , A., Barrios, MA, Ait -Ahmed, M., Machmoum , M., & Guerrero, JM (2022, October). Power management strategy with SoCs balancing of a battery powered shipboard DC Microgrid. In 2022 IEEE International Conference on Electrical Sciences and Technologies in Maghreb (CISTEM) (Vol. 4, pp. 1-6). IEEE. https://doi.org/10.1109/CISTEM55808.2022.10043944