Master Internship Project

Project title: **Study of a hybrid shore power supply system for ships**

Project description :

The decarbonization of maritime transport is increasingly becoming a necessity given the proportion of greenhouse gas emissions not only along maritime routes but also in port areas. To this end, the International Maritime Organization (IMO) recommends a certain number of measures including the modernization of ships through the use of less polluting fuels, and the integration of new clean energy sources. These measures also include the modernization of port areas, particularly through the installation of shore power supply, called also cold-ironing systems, to ensure the supply of essential electrical loads on board ships [1]. These power supplies are often connected to the main power grid. However, there are also autonomous power supplies 'disconnected from the grid' called security power supplies, making it possible to power ships at dock in the event of a power outage.

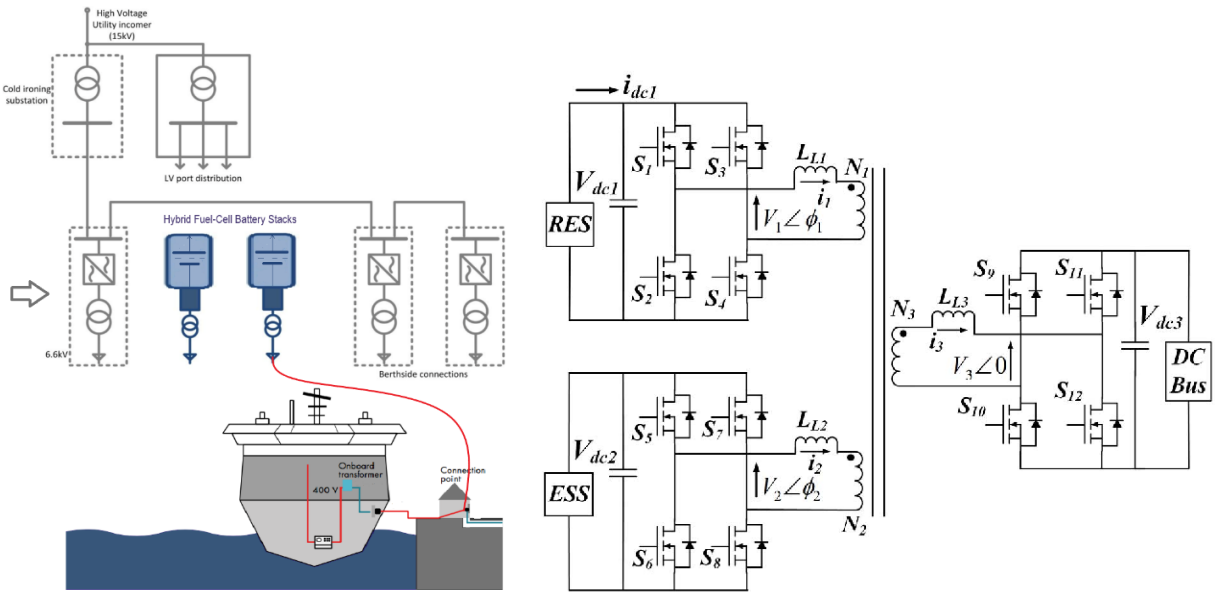

Fig. 1. Shore power supply (left), and configuration of the converter (DAB or TAB) used in this project (right) - where ESS: Energy storage system, RES: Source

The idea in this internship is to study an autonomous shore power system powered exclusively by clean energy sources (PV, fuel cells , etc.) combined with battery energy storage systems. For this purpose, suitable power electronics conversion interfaces will be used to ensure voltage scaling and to galvanically isolate the vessel from shore power. Different types of converters can be considered [2].

In this internship, we initially plan to study DAB – Dual Active Bridge type converters in order to increase the voltage level of the energy source used and to ensure protection. Secondly, we plan to study TAB – Triple Active Bridge type converters which allow two inputs; here the energy source and the battery. The objective will be to control these interfaces to ensure the desired output voltage levels and also to ensure the management of power flows; particularly for the discharge/recharge of the storage part [3].

Work organization :

The organization of the work envisaged in this internship will be as follows:

- A reappropriation of the state of the art linked to port shore power systems (existing technologies, electrical standards, types of converters used, etc.) and technologies linked to fuel cells. An internship has already been carried out on this topic which means that we will use it as a reference for the start of this work.
- Operational study and simulation on Matlab/Simulink of a shore emergency power supply supplied by a direct voltage source via a DAB type converter.

  Step 1 : Simulation of an isolated DC/DC converter – Closed loop control of Phase-Shifted Full bridge DC-DC Converter (Full bridge controlled DC/AC converter + Transformer + AC/DC Full bridge Diode converter) in MATLAB/Simulink
  Step 2 : Simulation of an isolated DC/DC converter – Fully controlled Phase-Shifted Full bridge DC-DC Converter (Full bridge controlled DC/AC converter + Transformer + AC/DC Full bridge controlled converter) in MATLAB/Simulink

- Modeling and control of the system: Choice of the control strategy and synthesis of the regulators for controlling the output voltage of the DAB converter – Simulation.
- Extend the study carried out in parts 2 and 3 to the use of a TAB type converter making it possible to hybridize the DC voltage source with a battery as illustrated in Figure 1.

Terms:

- Period envisaged 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** (compensation 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 **Djamel Ziane** . Do not hesitate to contact us if you need more information.

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References:

[1] Karimi, S., Zadeh, M., & Suul , JA (2020). Shore charging for plug-in battery-powered ships: Power system architecture, infrastructure, and control. IEEE Electrification Magazine, 8(3), 47-61. https://doi.org/10.1109/MELE.2020.3005699

[2] Sciberras , E.A., Zahawi , B., & Atkinson, D.J. (2015). Electrical characteristics of cold ironing energy supply for berthed ships. Transportation Research Part D: Transport and Environment, 39, 31-43. https://doi.org/10.1016/j.trd.2015.05.007

[3] Buticchi , G., De Carne, G., Pereira, T., Wang, K., Gao, X., Yang, J., ... & Liserre , M. (2022, September). A Multi-port Smart Transformer for Green Airport Electrification. In 2022 24th European Conference on Power Electronics and Applications (EPE'22 ECCE Europe) (pp. 1-8). IEEE.