

Master Thesis Project, 2022-2023

— Architectures of hybrid AC and DC distribution grids according to various usages —
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Context

The significant increase in energy costs encourages an increased energy independence by developing significant electricity production capacities but also by improving the efficiency of the electricity value chain. Distribution networks are strongly called upon to evolve due to the strong growth of distributed production based on renewable energy and new uses such as the electric vehicle. The cost of the electrical connection is a limiting factor in this transition. In addition, new needs for energy exchanges appear within the distribution networks, which were originally built to distribute electricity in AC form and unidirectional from the HV/MV source substations to the users. Depending on the distances and powers to be connected, a large panel of connection network architectures and technologies can be considered (AC, DC, mixed, etc.).

Objective

The objective of this work will be to compare DC network architectures for the connection of customers and to identify the most relevant for the society via an analysis, integrating the technical constraints of network operation and the economy of its development. The evaluation of the architectures will be based on the calculations of the annual energies to be distributed in the network, of the investment costs in hardware. To calculate these quantities, models and calculation methods will be proposed. It will be necessary to think on a generic formulation vis-à-vis the different architectures considered in order to evaluate them and compare them with an optimal sizing.

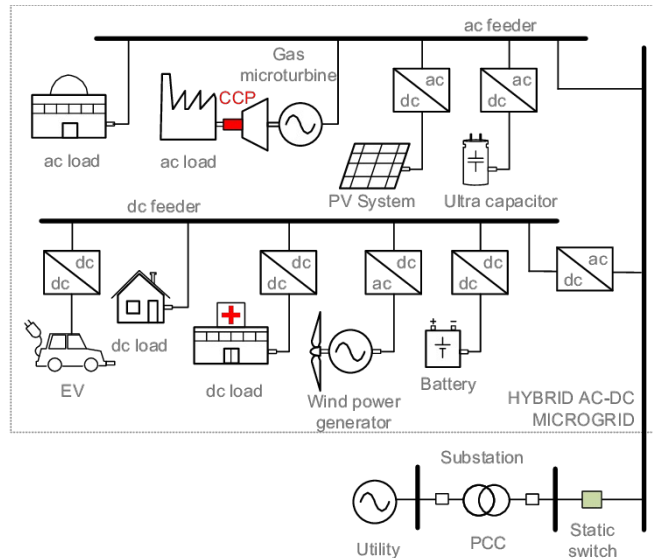


Figure: Example of hybrid AC DC architecture for distribution DC network

Work steps

The scheduled roadmap is:

- 1) a bibliographic project on the different DC and AC/DC network architectures in various applications (railway networks, embedded aeronautic and naval networks, DC building networks, ...), their technical constraints and benefits, their sizing (voltage level, cables, ...),
 - 2) a scientific project on the coding of an algorithm for sizing a DC network architecture for a specified distribution system with building consumptions and local PV production
 - 3) internship for extending the project work to other architectures as DC network for routing energy in an existing AC architecture. The study will be conducted in stages: (i) Determination and simplified modelling of generation and consumption sources, (ii) Determination and modelling of different distribution network architectures (hybrid and full AC) that can accommodate these sources, (iii) Definition of case studies, (iv) Numerical simulations, (v) Impact analysis of the different solutions on the existing AC distribution network.
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Key word

AC/DC hybridization, DC grids, renewable energy sources, network architecture design, power management, electrical network operation, planning.

Application

CV + motivation letter + academic results of the two past years.

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