DRT: Thesis SL-DRT-21-0386

RESEARCH FIELD

Energy efficiency for smart buildings, electrical mobility and industrial processes / Technological challenges

TITLE

High efficiency power electronics transformer for renewable energy sources connected to the grid

ABSTRACT

The primary sources of electrical energy used in renewable energy systems are mainly with DC ouputs :

We can indicate below, the main voltage characteristics of the power sources :

-Photovoltaïcs (1.5 kVDC)

-Energy storage systems (800V-1.5kVDC)

-EHT Stacks (950 VDC)

-Electric vehicle batteries (800VDC)

On the other hand, the new energy transmission grids are also in DC :

-HVDC: 100 kVDC to 1.6 MVDC

Some rail power systems are also direct current:

-Rail: 1.5 kVDC, 3 kVDC, SNCF 6 kVDC (experimental network project)

DC collector architectures are foreseen in the following applications:

-Distribution of energy in charging stations for electric vehicles

-Onboard networks of naval propulsion machinery

-Electric conversion chains for electric railway traction units

-Production of photovoltaic energy

-Stationary storage of electrical energy

The objective of this thesis will be to obtain a modular DC / DC power electronics building block compatible with

the voltage levels delivered by the ENR sources and allowing injection on the medium voltage DC.

The electrical insulation of the primary sources will be unchanged: it will therefore be necessary to provide,the isolation of the sources through a very high efficiency transformer technology (> 99.5%) integrated at medium frequency into the conversion stages.

The transformer will be one of the key elements of the problem and as such certainly the support for many innovations in terms of the use of magnetic materials (depending on the frequency range and the specification : amorphous materials, cut nanocrystalline, or specific ferrites can be used), the mechanical arrangement of these materials (orientation, charge rate, morphology), the electrical arrangement of the windings as well as the thermal management of the assembly, while ensuring an appropriate dielectric strength.

-Injection can be done on a 6 kVDC network (SNCF experimental network)

-The power electronics will be produced with high-voltage SiC semiconductors whose performance are far superior to Si équivalents semiconductors .

The DTNM and the Ampère laboratory will provide their expertise on magnetic materials for the sizing of the transformer integrated in the conversion stages while the DTS will provide it's expertise in prototyping of medium/high power converters, prototyping of transformers , and also characterizations of power components.

LOCATION

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