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RESEARCH TOPICS

1) ULTRAFAST AND WIRELESS EV-CHARGING STATION

A modular multilevel converter (MMC) architecture has been proposed for the ultra-fast charging of road electric vehicles with the integration of distributed energy storage systems. An appropriate design for a modular multilevel converter architecture and different control strategies were presented, taking into account its integration with energy storage modules of different technologies.

A 'wireless' charging systems have been studied with particular reference to the stationary charging of electric vehicles and a first prototype was developed for the 'wireless' charging of an e-bike.

2) MODULAR MULTILEVEL CONVERTER

One emerging solution either for high- or medium- voltage transformerless power conversion is represented by multilevel converters as interface for grid-connected PV systems. This activity is focused on study, modelling and control of modular converter topology. A dedicated P&O MPPT permits to control independently the voltage of each dc-link, increasing the power extraction even in mismatched conditions. In order to prove the effectiveness and feasibility of the proposed approach, a set of experiments are performed on a laboratory prototype of a single-phase five-level PV CHB.

3) TECHNOLOGIES, METHODOLOGIES AND COMPONENTS FOR ENERGY SAVING IN LIGHT RAILWAY AND ROAD VEHICLES

These studies were conducted in the framework of the research project SFERE with Ansaldro Breda (now Hitachi Rail Italy) . The objective of the project was the realization of an on-board storage system for energy recovery during the braking operations of light railway vehicles and the opportune energy management control. The aim of the control was to recover, in a supercapacitor storage device, the maximum energy regenerated during a train’s electrical braking and to limit the contact line peak current. Experimental tests were conducted on an electromechanical simulator realized in TRLab.

4) ADVANCED SMART-GRID POWER DISTRIBUTION SYSTEM

This topic has been focused on design and control of DC/DC resonant cellular converter with automatic inversion functionality for advanced smart-grid Power Distribution in aircraft application. The key element in order to implement this approach will be a newly designed DC/DC Power converter hereafter referred to as a

"cell". The study will design and manufacture at least 4 innovative cells to form a cellular power converter and also developing, implementing and validating the overall energy management strategy. Overall activity will lead to a weight and volume reduction and to improve the system reliability. This activity actually is working in progress for European Project called ASPIRE in Clean Sky Framework.

5) ELECTRICAL GENERATORS AND SMART-CONVERTERS FOR RENEWABLE ENERGY APPLICATIONS

This research activity analyses different solutions of electrical generators and power converters for renewable energy applications. Different advanced configurations of dc-ac and dc-dc converters have been developed with the aim to maximize efficiency and performances. Moreover, some non-linear control algorithms have been developed to assure fast dynamic response and ancillary services to the grid. As electrical generators, new outer rotor configurations of PM Flux switching machines have been developed with improved performance in terms of power density and dynamic response.

6) ELECTRICAL DRIVES WITH HIGH POWER DENSITY PM MOTORS HAVING FAULT-TOLERANT CAPABILITIES FOR MORE ELECTRIC AIRCRAFT APPLICATIONS

The topic deals with motors and converters, also in multi-phase configuration, with high number of poles and high frequency, for direct coupling with airscrew of light aircrafts; the objectives of the research are the sizing of high power density motors and the development of optimized strategies for power train control and techniques modulation of power converters.

7) PM BRUSHLESS ELECTRICAL DRIVES IN A DUAL-MOTOR SINGLE-INVERTER CONFIGURATION

The investigated drives have two (or more) PM brushless motors of different sizes and/or power supplied by a single inverter. Several control techniques are developed with different optimization targets, i.e. energetic optimization or fast transient stabilization and so on.

8) CONDITION MONITORING AND SMART PREDICTIVE MAINTENANCE OF ELECTRICAL DRIVES FOR RAILWAY APPLICATIONS.

The activity research deals with development and application of models and techniques for diagnosis/forecasting of the most frequent faults in an electric drive for railway traction; the research requires that the analysis of the electrical/mechanical quantities of interest must be performed directly using microprocessors located on the individual components constituting the drive, optimizing the management of Big Data and the number/ uality of the information sent to the "control room" supervision.