1. Publishable summary

In recent years, the world has experienced a massive climate change. There are many contributors to that happening such as carbon emissions resulting as an increase in air transportation. In the grand scheme of moving towards greener aircrafts, reducing aircrafts fuel burn and emissions by significant margins and moving towards more electric aircrafts have been one of the priorities in aeronautical research programmes.

ROTOPOWER — is an EU-funded CfP carried out in the FP7 CleanSky aeronautical Research Programme. It is a bottom-up approach of 1 partner and 1 Associate to develop high performance power electronic converters. The principal aim of ROTOPOWER is to produce high performance power electronic converters that will be able to control the electrical machines used to actuate the main rotor swashplate of a medium sized rotorcraft. The project will involve Castlet Ltd which Aerospace Marine and Ground Division is a world leader in providing high tech electronic and power electronics solutions.

The main objectives of ROTOPOWER are:

- To complete the preliminary research, design and all technical documentation and modelling of the high performance power electronics converters.
- To complete a device trade study
- To produce two prototypes high performance power converters for final testing
- To complete a design update for any underperformance observations or potential design improvements obtained from the initial testing of the prototypes
- Produce all remaining prototype equipment
- System testing of prototype hardware at team site

ROTOPOWER has organised its work around 6 work packages (WPs). The main objectives and results were:

WP1 has gone through the process of completing a preliminary research, producing all detail design aspects inclusive of mechanical, thermal, electronics, control and software. The technical part of this effort was projected to be completed in the early months of 2013. At that point, all requirements were gathered from the project team to define and identify the appropriate functionality scheme of the power converter. A second concerted effort was firstly to perform a simulation of the electrical machines drive used to actuate the main rotor swashplate; secondly to design a filter to meet power quality requirements when the electrical machines are operating; finally to design a cooling system for the power semiconductors used in the electrical machines drive. A third effort was to finalise all schematics design once the simulation activities were completed. In parallel to the schematic design, a trade study was completed to decide on the appropriate devices to be selected for the power electronic converter. The highlights of this work during the first 12-months were the completion of the PCB layouts, the CAD design of the power electronic converter case and its cooling system, and finally a well-defined weight estimation of the preliminary design.

WP6 has for goal to complete a device trade study for potential inclusion within the preliminary design. There is a huge variety of components and many manufacturers do exist on the market. As the high performance power converter is to be used in aerospace applications, the selection criteria were based on military and aviation requirements and standards. The key selection parameters were the operating environment, the power quality,

component lifetime, durability and reliability. During the first 12-month project period we have explored various devices and connectors, and selected the appropriate for the design.

WP2 here the team has to produce two prototype high performance power converters for initial testing following the pre-design work achieved in previous work packages. The bulk of the effort in this work package was to firstly procure all necessary components defined during the device trade study, to manufacture and populate all PCBs, thirdly to test them for functionality, then to manufacture cases for both prototypes and finally to assemble all the previous to make the complete high performance power converter. During the first 12-month project period the power converter (shown in Figure 1 below) partially assembled was tested at Castlet mainly for functionality according to the preliminary design review requirements.

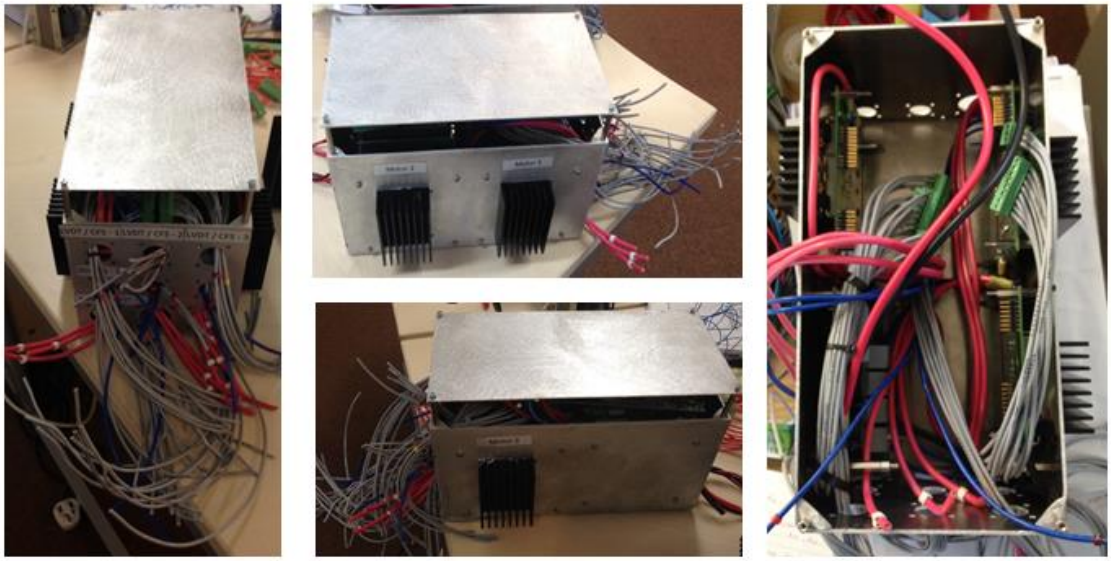

Figure 1 *- Prototype view s of the power electronic converter*

During the first 12-month project period ROTOPOWER partially produced and tested two high performance power electronic converters through various activities.

WP3 consists on an in depth review and analysis of tests performed on the first two prototypes, and to complete a design update for any underperformance observations or potential design improvements obtained from the initial testing. The technical part of this effort was projected to be completed in the early months of 2014. At that point, all initial testing would be performed by the project team to observe and analyse the full functionality of the power converter. A second concerted effort was to establish design changes to be implemented on the power converter. A third effort was to implement all agreed changes to meet the critical design review stage. The highlight of this work during the second 12-months was the completion of all design updates post initial testing for the critical design review which led to a modify second prototype shown in figure 2 below.

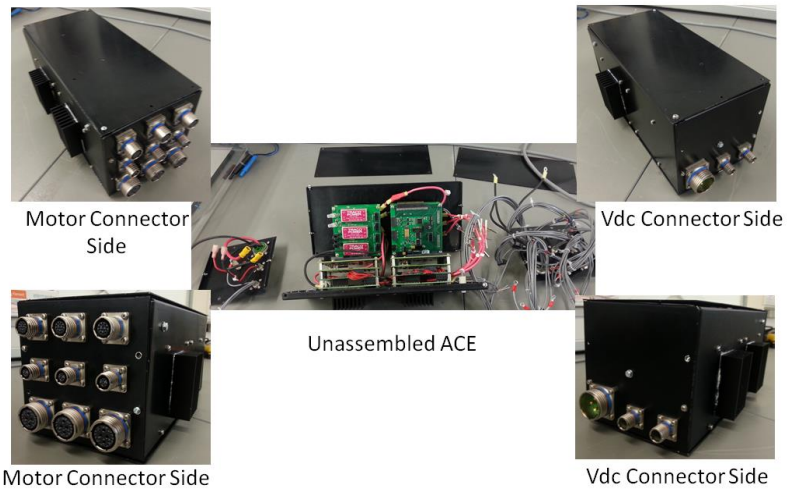

***Figure 2** - Views of the modified second prototype power electronic converter*

WP4 has for goal to complete the manufacturing of all remaining prototypes equipment. The bulk of the effort in this work package was to firstly procure all necessary components defined during the device trade study, to manufacture and populate all PCBs, thirdly to test them for functionality, then to manufacture EMI gaskets and cases for all remaining prototypes, and finally to assemble all the previous to make the complete high performance power converter. During the second 12-month project period the second prototype power converter (shown in Figure 2 above) were tested at Castlet mainly for functionality according to the design requirements. During the last 9-month project period the final seven prototypes power converters (shown in Figure 3 below) were tested at Castlet mainly for functionality according to the design requirements.

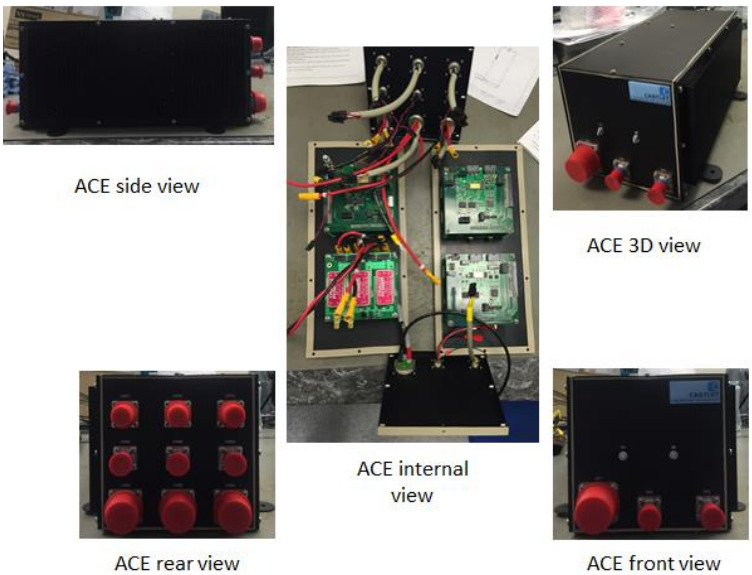

***Figure 3** - Views of the Final power electronic converter unit*

WP5 consists on providing support during the system testing of all final power converter units. At this point, all initial testing would be performed by the project team to observe and analyse the full functionality of the final power converters. A second concerted effort was to perform further functionality tests to validate the full functionality of the power converters. A

third effort was to assist during the system testing of power converters. The highlight of this work during the last 9-months was to provide support when needed during the testing of the converters.

With these integrated activities, ROTOPOWER promotes research activities in the domain of power electronics in a quest to achieve more sustainable greener aviation. To achieve this goal, the most important task is to achieve the design and development of all high performance power electronic converters for their integration with the electromechanical actuators they will be controlling. The results from our work will be published in scientific journals and will be part of a larger demonstrator to be presented at various air shows. ROTOPOWER also provides a key component in the HEMAS (Helicopter Electro-Mechanical ActuatorS) test rig for Helicopter swash plate actuation which will highlight one of the multiples research activities carried so far to promote first steps achievements towards More Electric Aircrafts (Green ROTORCRAFT). Because ROTOPOWER is part of a much bigger collaboration including Aircrafts manufacturers, Helicopter manufacturers and their suppliers, the potential of achieving new aircrafts and helicopters integrated structures for greener aircrafts is certain.