

# ICT PHD

Research project for a PhD curriculum in ICT –Industrial Applications of ICT

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**Proposed Title of the research:** Design of electric drives for a more sustainable agriculture

**Keywords: (5)** Electrical machines, power density, Sustainability, Torque density, Electric Tractors

## **Research objectives: --(max 10 rows)**

Electrification in off-highway vehicles, such as tractors, is still in its initial stage. For these vehicles, movement is only a limited part of the work activity, as mechanical power to the power take-off (PTO) or hydraulic controls is typically required.

This results in difficult identification of the best electrification strategy for the vehicle. However, interest in electric or hybrid tractors is on the rise. This is confirmed by both producers and the European Agency, which promotes initiatives in the field of sustainable growth, such as the Flagship Initiative "Resource efficient Europe".

The proposed research aims to obtain an improvement in the environmental sustainability of the vehicles and tools used in agriculture, in a manner consistent with the objectives of the national plan of recovery and resilience PNRR.

In particular, the specific objectives of the project are the following:

- Identification of components to be electrified in vehicles, definition of requirements and their sizing (motors, converters and related controls);
- Design of a prototype electric machine with high power and torque density to be used for electrification applications of agricultural tractors;
- validation and testing of some electrification configurations on small-scale components.

## **Proposed research activity -- (max 10 rows)**

The project will identify the type of electric motor EM most suitable for the characteristics of the application in question. The study will take into consideration the ability of the EM to work in flux-weakening and in overload conditions.

The simulations of electric motors will be carried out with advanced techniques, considering both analytical and finite element simulations. A wide range of machine models and software for machine analysis has already been developed in UNIMORE.

In addition to electromagnetic analysis, thermal and mechanical analysis will also be included, according to a Multiphysics approach, capable of maximizing the performance and power density of the electric machine.

## **Supporting research projects (and Department)**

The successful candidates will become part of the research team of electrical machines and converters of the University of Modena and Reggio Emilia, which has been working for some time on the issues of electrification with collaborations and participation in research projects at national, European and extra-European level. UniMore will make available the MeltingLab laboratory which collects equipment and devices for the design and test of converters and electrical machines, in addition to the main SW used for the study and sizing of these.

## **Possible connections with research groups, companies, universities.**

The activity will be carried out in close collaboration with the CNH company, which will make available its laboratories and databases of measurements collected in the field of the main operating parameters of the tractors. These data will represent a fundamental source of information for the definition of the hybrid architecture that will be developed.

A period of work at one of the company's foreign offices is provided for a minimum period of 6 months. To this is added a period of 6 months at the CNH headquarters in Modena, for the study and collection of the data necessary for the research survey.