Ismail El Hamzaoui

PhD Student at UPNA

Ismail is from Ifrane, in the Atlas Mountains in Morocco.

BSc in Engineering and Management.
MSc in Sustainable Energy Management.

Specialized and passionated in renewable energy systems and their integration into the grid, wants to make a significant contribution in that field.

He did his Master Thesis Research Project during his participation on the Mobility Program Erasmus in Pamplona, at the Institute of Smart Cities of UPNA, within a real-life project to make the electric bus line of Pamplona more green, sustainable and reliable. (STARDUST EU Horizon 2020).

Ismail has joined the INGEPER group (Renewable Energy Grid Integration group) led by Prof. Luis Marroyo. His Thesis Supervisor is Dr. Jesús López Taberna, who is also Professor of the Electrical and Electronical Engineering Department at UPNA.

Research

Studying the additional mechanical loads on grid connected DFIG wind turbines operating under grid-forming mode.

Research objectives: Studying the mechanical stress on wind turbines operating under a grid-forming mode of operation. Comparison between DFIG and full-converter wind generators.

Can the turbines mechanically withstand their new responsibilities in the electric grid as they are set to replace traditional synchronous generators as grid stabilizers? Primary assessments show that additional stress is induced by the machines: measurement of which and solutions are subject to study.

Abstract:

The integration of renewable energy sources into the power grid is pivotal for achieving sustainability goals. This research focuses on the mechanical stress experienced by grid-connected wind turbines, specifically Type 3 (Doubly Fed Induction Generators, DFIG) and Type 4 (full-converter wind generators), as they transition to perform grid-forming operations. These operations are essential for stabilizing the grid, a role historically undertaken by traditional synchronous generators.

The study aims to evaluate whether these wind turbines can withstand the additional mechanical stresses imposed by their new grid-stabilizing responsibilities. Initial analyses indicate that transitioning to grid-forming operations subjects the turbines to increased mechanical stress, potentially affecting their longevity and efficiency. Through comparative assessments between DFIG and full-converter systems, this research seeks to quantify the added stress levels and explore electric control solutions to mitigate these impacts.

The outcomes of this study are expected to contribute to the design of more resilient wind generation systems, ensuring they can effectively fulfill their role in a sustainable energy future. By addressing the challenges of integrating wind energy into the power grid, this research aims to enhance the reliability and efficiency of renewable energy sources, supporting their expansion and the transition towards greener power systems.

Year 1 objectives:

- Development of high fidelity EMT electric models of grid-following and grid forming wind inverters (controls and grid modeling).
- Successfully coupling the electric models with advanced mechanical models developed by **CENER (Centro Nacional de Energías Renovables)** as part of a two-year project collaboration over the questions of this PhD thesis.

'Measuring the mechanical stress on "grid forming" wind machines is the main obstacle right now to the deployement of this new generation of wind turbines in the grid.'

'The new generation of wind turbines inverters needs to be designed differently, not only from the electrical point of view but considering the mechanical impact on the wind machines too.'