DeSIRE tenure track position #12: Electromagnetic energy conversion for a more resilient society

University: Eindhoven University of Technology

Department: Electrical Engineering

Responsible Professor: Prof. Elena Lomonova (E.Lomonova@tue.nl)

Description:
Electrical energy plays an important role as energy carrier in a more sustainable society. It can be generated, transported and converted efficiently and cleanly to any desirable appearance, e.g. for lighting, heating, or transport. Power electronic converters are required at every conversion stage to control and change the appearance or voltage level. The fundamental functions needed in power electronics converters include: switching elements, control to execute all operation correctly, both spatially and temporally, electromagnetic energy storage and transformation, EMI filters, thermal management and mechanical/structural stability.

In this tenure track the electromagnetic energy conversion principles and materials are researched to significantly improve the conversion and routing of electrical energy. For a more resilient society, the controllability and reliability are the subjects to be improved compared to state of the art conversion methodologies. A detailed analysis is needed on electro magnetics and new materials. The magnetic components are composed of (no-) grain-oriented electrical steel, soft magnetic composites or solid ferrite materials, with very good magnetic properties. However, the non-linear magnetic behavior of electromagnetic components greatly affects the performance electromagnetic energy conversion in terms of efficiency, size, EMC and particularly cost. To predict these performance indices during a design process or make a priori estimations based on specific operating conditions, time-efficient analyses and design tools are necessary.

Current (design) tools, although very fast, are based on simplifications of the electromagnetic behavior and are for this reason inaccurate in predicting various performance aspects. They also give little physical insight, preventing new innovative concepts to find their way into the magnetic design. Even academic or commercial software combining all material (anisotropy, magnetostriction), design (3-D field distributions) and manufacturing related effects (such as assembly tolerance, stress distributions), is not available. As such, new topologies, performance optimization, weight reduction, and efficiency improvement of magnetic components and devices are limited especially when tailored to high frequency domains.

A methodology will be created in which the design of electromagnetic energy conversion mechanisms can be optimized. The electromagnetic design methodology will be established in such a way that physical EM-relevant parameters, EM-models, EM-analysis setups and EM-tool flow are combined in order to establish a common design, validation and analysis methodology (this has to be carried out by a cross domain approach with consideration of domain specific requirements).

Position in framework of the programme (please delete what is not applicable):
- Approaches/discipline:
  mathematical modelling/ cross-cutting methodologies/ Resilient maintenance
- Scale/application area:
  Cities & regions of interconnected mid-size towns/ Urban - Infra / Agri-Food

Synergy with other tenure track position(s):
- Resilient asset management and maintenance (TU/e, Industrial Engineering & Innovation Sciences)
- Cyber-physical energy system resilience (DUT, Electrical Engineering, Mathematics and Computer Science)