Advanced Control methods for Residential Energy Router

Summary

The goal of this research consists of the development of the advanced control techniques for ER taking into account high-switching frequency operation and high power density. The control must be extremely reliable and robust and suitable for industrial application.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Dr. Dmitri Vinnikov Oleksandr Husev
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between September 01, 2021 00:00 and September 30, 2021 23:59 (Europe/Zurich)

Description

It is a well-known fact (since Edison-Tesla “current-war”) that ac voltage level can be easily stepped up or down by means of a transformer. The effective electrical energy distributed system can be constructed. Recent works show that even a high-voltage dc-current distribution system is more effective than a high-voltage ac system.

At the same time, it is evident that transient from ac to dc grid cannot be done immediately. In the nearest decade, we will observe a merge of dc and ac systems. As a result, the power electronics facilities that have the ability to merge dc and ac grids are required. The Energy Router (ER) concept becomes even more important and demanded. The price, universal usability, reliability, efficiency and proper control algorithms are key issues to be solved.

The goal of this research consists of the development of the advanced control techniques for ER taking into account high-switching frequency operation and high power density. The control must be extremely reliable and robust and suitable for industrial application.

This research direction includes the following tasks:

1. Review and evaluation of various topological solutions suitable for ER concept.
2. Review and implementation of the control algorithms that have to provide multifunctional operation of ER: grid-connected operation (dc and ac grids), MPPT, battery control.
3. Development of advanced control techniques taking into account high switching and sampling frequency (50-100 kHz) feasible for practical implementation (based on low cost microcontrollers available on the market).
4. Investigation of power density and cost optimization of the proposed solutions.
5. Development of the industrial prototype of new 5 kVA single-phase ER.

Applicants should fulfil the following requirements:

- Practical experience in the design of electronic systems
- Experience with programming of microcontrollers for power electronics application
- Experience with electronic circuits modeling in (Matlab, PSIM or PSCAD)
- Experience with mixed signal PCB design (preferably using Altium Designer)

- Experience with closed-loop control systems featuring analog and digital sensors

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