High-efficiency Inverter for Home Storage Systems

Master thesis project

Summary:

The aim of this thesis is the use of solar and wind energy for powering a home-based battery energy storage system. The residential battery market is expected to grow at a CAGR of 18 % from 2023-2028 (Source: Mordor Intelligence). This thesis aims to enable such a home battery to be connected to the grid by means of a high-performance inverter.

Problem definition:

Converting energy from a low-voltage (48V) battery to the 230V ac grid can be done in multiple ways. New wideband semiconductor technologies like SiC and GaN MOSFETs open new opportunities.

Method:

In this study, we wish to investigate which topology is most effective for a home storage inverter for use as a grid-tied battery inverter (efficiency, cost, power quality).

Research objectives:

1. Perform a literature survey on LiB-based battery solutions for home applications (48V) and centralized inverters suitable for integration with the ac grid (230 V, 50 Hz).
2. Study several parameters including power, scaling, weight, efficiency (under different operating conditions), energy and power density and relevant KPIs for the inverter.
3. Model the system using PLECS and consider benchmarking a typical most-suitable topology and compare with high-performance, low-loss topological options.
4. Perform simulations and build a suitable protype for the same application and perform lab-scale testing.
5. Validate the design using experimental analysis and perform electrical characterization and performance parameters (efficiency, losses, integration with grid)

Courses and supervision:
This is a a challenging, hands-on power electronics project. Background of EE and power electronics and battery-related courses are considered mandatory.

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