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Flywheel-based resilient energy systems for smart cities and transportation infrastructures

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The talk will cover detailed solution of Flywheel Energy Storage Platform (FESP) for transportation/transit, including buses and railways. FESP will have integrated schemes and technologies to ensure optimum and high efficient energy system. FESP includes flywheel energy storage system, which is one of the most promising technologies for replacing conventional lead acid batteries as energy storage systems for a variety of applications, including automobiles, economical rural electrification systems, and standalone remote power units commonly used in the telecommunications industry. FESP can be applied as alternative technology for currently installed batteries, or to be integrated with them as a hybrid energy storage system to achieve optimum performance. FESP will be integrated with advanced dynamic control scheme to enhance the performance and storage capabilities of the flywheel, reduce the charging time, and to increase the operating lifetime. A key feature of the proposed solution is to provide a replacement energy storage module at charging stations to reduce the charging waiting time in some cases as well as to achieve optimal operating costs. This requires control action to optimize the decision to charge or replace at each station. In order to achieve global management and optimization of the bus (or transit) systems, an integrated Bus Energy Management System (BEMS) is proposed to the following functions: (a) monitor and control the FESP in each bus during the trips; (b) monitor and control the charging of FESP at the charging stations; and (c) monitor and control the replacement of energy storage module at the charging station. These decisions will be based on economic and technical optimization criteria. This talk will explain best practices and practical ways of implementation of the FESP in worldwide transportation/transit applications.

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About the environmental and economic performance of different battery technologies for stationary energy storage

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Energy storage is becoming increasingly important for future electricity systems, and batteries are considered as one of the key technologies for this purpose. However, their production is cost- and greenhouse-gas intensive and continuous efforts are made in order to decrease their price and carbon footprint. Furthermore, different battery technologies are available, each with its specific (dis-) advantages. We use a combination of life cycle assessment, Monte-Carlo simulation and size optimization to determine life-cycle costs and greenhouse gas emissions of different battery technologies in stationary applications. Different application cases with dynamic load profiles are considered in order to point out the importance of choosing the appropriate battery for a given application. The size optimization determines the best trade-off between battery oversizing and increased battery replacements under economic aspects. It turns out that battery life is a determining factor for cost and carbon emissions. This is not only due to the amount of battery replacements required, but also due to oversizing needed for battery types with low cycle lives in order to reduce degradation effects. Most lithium-ion batteries, but also the sodium nickel chloride battery show a good performance in all assessed application cases, while valve regulated lead acid batteries seem to be less recommendable due to low cycle life and low charge-discharge efficiency. For redox flow batteries, a high dependency on the desired application field can be pointed out.

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