High-Temperature Superconducting Power Applications to Meet Major Challenges in Energy Systems

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***Abstract*— In recent years, many large-scale demonstrators and prototypes of high-temperature superconducting power applications have been developed successfully. This includes for example kilometer long cables with first long term installation [1], multi-megawatt rotating machines for wind generators [2] or high voltage fault current limiters for grid protection [3]. For most of the applications the technical feasibility and the ability to fulfill all operating requirements was demonstrated impressively several times. This progress was also enabled by 2nd generation high-temperature superconducting tapes with still increasing performance to cost ratio and higher availability. In a few niche applications high-temperature superconducting power applications can be economic today but with further development of tapes and cooling technology, a broader range of applications are envisaged to be soon economic feasible.**

Today, the transition of the energy system towards fully sustainable systems with a high share of renewables and more energy storage is taking place worldwide. This means that the central power supply will be restructured towards decentralized systems with a more local control. In addition, particular attention is given to saving of energy and resources. In this context, high-temperature superconducting power applications can play a prominent role to meet the challenges in our energy systems. In general, they are much more compact and enable a higher efficiency, but they are even more attractive if additional system benefits arise. For example, with high-temperature superconducting cables, the next voltage level can be avoided when transmitted power is increasing.

This presentation summarizes first the major power system challenges and further expected developments. Based on this, for each of the different applications (cables, fault current limiters, rotating machines, transformers and superconducting magnetic energy storage) an overview of the state of the art is given by showing the timeline of the development and by depicting important lighthouse projects in more detail. Finally, an answer is given for each of the applications how they meet the major challenges in power systems and what R&D activities can be most relevant.

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