Modelling & control of switched power converters and power grids

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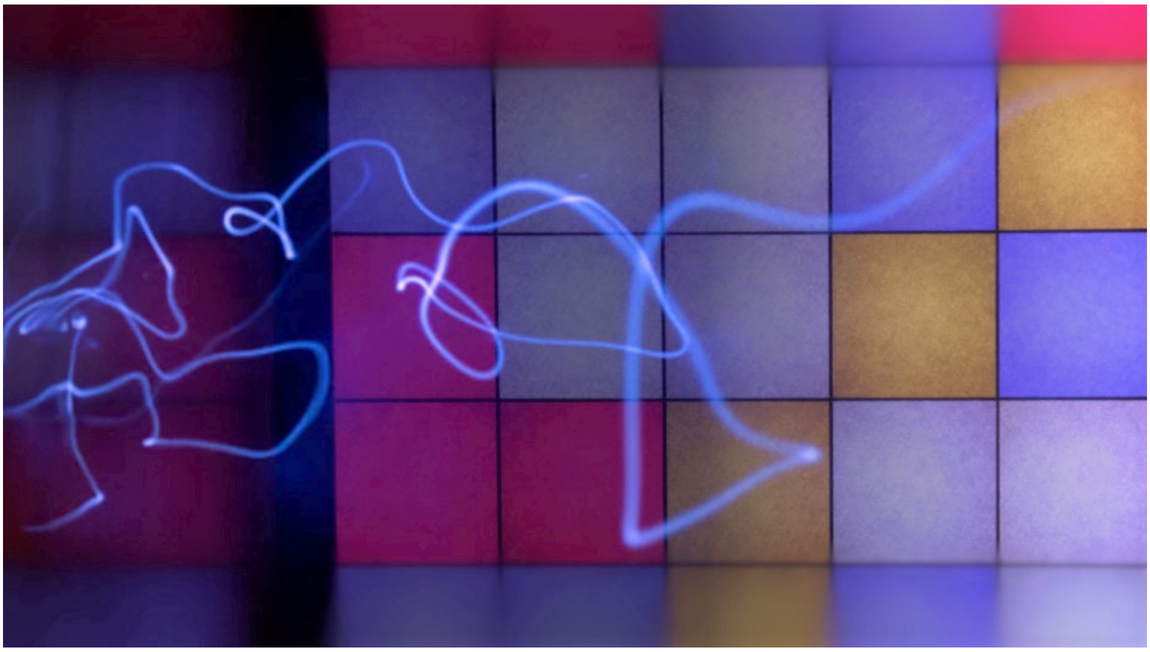

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Our society moving away from traditional energy sources towards renewable energies, we have to rethink one of the biggest ”machines” that humans have invented: The electric power grid, spanning a cumulative distance of over 4 million km[1]. It also is a highly decentralized system and amazingly works quite well due to inherent stability properties of the huge generators employed in traditional power plants (Coal, Gas, Nuclear, Water). Today, adding more and more renewable energy sources, we provide more and more energy by inverters: Machines that create the grid’s alternating current using electric circuitry instead of large rotating generators with their inherent inertia. This fundamentally impacts the global properties of the grid, such that today, we we have to investigate into one of the core requirements: Grid stability. My work focuses on new inverter algorithms that are used to generate the alternating voltage and current to inject power to the grid, providing stability by using virtual inertia, virtual friction and other concepts that often mimic real generators. To understand the grid better, we try to find equations describing it’s dynamics while keeping them ”simple” enough to be analyzed analytically. We also perform more complex simulations under extreme conditions and run experiments with small scale power grids, to understand the behaviour of our inverters in realistic settings.

[1]Global Transmission Report - Global TSOs: Growth in transmission networks of leading TSOs https://www.globaltransmission.info/archive.php?id=36488, accessed 18 October 2020

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