

## **Flywheel based power quality improvement in a medium voltage grid**

Abstract

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Voltage sags of up to 7% nominal voltage lasting between 70 and 2000 ms have been measured in a 16 kV grid close to Zurich/Switzerland. The sags are caused by short-circuit tests made in a high current laboratory.

Since a direct integration of the laboratory into the high voltage grid would be too expensive alternative solutions had to be found to protect the remaining consumers within this grid from the voltage distortion. Due to the dynamic behaviour of the sags conventional technologies such as static var compensators or controlled tapped transformers fail for compensation.

However, a voltage source inverter (VSI) inserting a variable voltage in series with the line can keep the voltage level within an acceptable tolerance. An energy storage unit can provide the needed active power.

First tests using a 70 kW flywheel system in a small grid with 1 MVA load proved the general feasibility of this technology. The flywheel coupled with an electrical synchronous machine feeds the missing power to the line VSI via a DC link. The added voltage in phase and amplitude and the flywheel's stored energy is controlled by a microprocessor based control unit. Measurements show that the power quality can be significantly improved as voltage distortions with frequencies between 0.1 up to 1000 Hz are almost completely compensated. A pilot installation is planned and is scheduled to be operational at the beginning of 1998. In addition simulations have been performed on various topologies, including some without energy storage unit. Different storage technologies like batteries, SMES, capacitors and flywheels have been compared. The possibilities of making use of reactive instead of active power have also been investigated.