Implementation and Dynamic Validation of an Adaptive Protection System in a Microgrid with Voltage Controlled Inverter

M. Valov
M. Nuschke

Contact: maria.valov@iee.fraunhofer.de
Phone: +49 561 7294-296

Fraunhofer IEE
Königstor 59
34119 Kassel / Germany
www.iee.fraunhofer.de/en

Microgrids are getting more attention – protection needs to be reconsidered!

- Grid forming inverters allow islanding operation without any synchronous generation. Flexible protection concepts are essential.
- Investigated test system consists of a static aggregated load, a voltage controlled inverter (VCI) connecting PV and battery, and a current controlled inverter (CCI) for a battery.
- Possible operation modes:
  1 - Grid connected
  2 - VCI and CCI supply load in islanding operation
  3 - VCI supplies load in islanding operation
- A microgrid controller (MGC) updates protection settings of intelligent electronic devices (IED).

Impact of Inverter Based Grids on Protection

- Limited short-circuit contribution of inverters
- Black start capability of grid forming inverters
- Varying power flow directions
- Magnitudes of short-circuit currents tend toward load currents

Impact: Classical non-directional time-overcurrent protection with a single setting group becomes inadequate.

Enhanced Protection Concept

Proposed protection concept uses the potential of employed overcurrent relays and is enhanced with additional protective functions:

- Adaptivity
- Directional blocking
- Directional transfer trip
- Blocking during voltage recovery

Requirement: Communication infrastructure between IEDs and MGC but also among the IEDs for fast transfer and blocking signals.

Investigation Results and Conclusion

MGC identifies the prevailing operation mode and adapts the protection settings. Fig. 3 shows exemplarily the adjusted relay settings for the transition from operation mode 1 to 2.

Automatic adaption of relay settings combined with the utilization of directional overcurrent IEDs and additional protective functions increase dependability and selectivity of protection systems. Flexible and reliable operation of microgrids can be enabled!

We acknowledge the support of our work by the German Ministry for Economic Affairs and Energy and the Projekträger Jülich within the project "NETZ.KRAFT: Netzwiederaufbau unter Berücksichtigung zukünftiger Kraftwerkstrukturen" (FKZ 0325776A).