#2 Failure management in the MV network in the Demo1

Type of solution
Equipment / Hardware / Firmware to Information system to Process
Manufacturer(s) implied (for equipment or hardware)
ABB
Work Stream considered
• DER integration • MV Innovation
Location / Topology (with regards to distribution grid)
• HV/MV Substation • MV/LV SS
Thematic(s)
• Grid Monitoring / state estimation • Automatic Failure Detection • Remote Grid Operations • Automatic Failure Management / Grid recovery • Automatic Grid topology reconfiguration
Use Case(s)
Failure Management in MV networks
Key figures
MV grid with: • ~100 secondary substations • 7 switching modules • 11 measurement modules

Table- 4 – Failure management in the MV network in the Demo1

Context and objective

The high share and still massively increasing amount of distributed generation, predominantly wind and photovoltaic, set new challenges to the DSOs in Germany. In order to provide hosting capacity to integrate these resources huge investments in grid infrastructure are required. Moreover, grid operation and grid observation become more complex since power flows become less predictable. At present in Germany there are hardly any surveillance facilities or grid automation in place in medium voltage networks.

Demo1 addressed these challenges with the demonstrator built up in the area of “Reken”, located in North Rhine-Westphalia. The principle idea is to implement an autonomous switching system that is based on an autonomous interaction between these modules and a lean control centre in the primary substation. The modules are divided into two groups: Switching Modules and Measuring Modules. Switching Modules can execute the switch gear of their secondary substation whereas Measuring Modules provide measured values. The possibility of autonomous switching provides dynamic topology reconfiguration which is a new concept of operation.

The installation of an autonomous switching system aims at reducing the time of fault localization and isolation. To investigate whether a reduction actually takes place with a smart grid solution, a KPI is defined in GWP2.2. This KPI tries to quantify the reduction of time. To illustrate the benefit of an autonomous switching system, the standard operation procedure is described first without an autonomous switching system (baseline scenario). Then, it is described after the installation of an intelligent switching system (smart grid scenario). Demo1 analysed the benefits concerning failure management by simulating three different faults and comparing the baseline scenario with the smart grid scenario.

Development and implementation

Failure management is a crucial operation work for every DSO. The traditional approach without smart grid facilities – referred to as baseline scenario – relies on the experienced work of the operation teams and the SCADA-engineers. With the installation of the autonomous switching system these working groups receive tools for a more efficient and quicker way of failure management.

Failure management without autonomous switching system

In the baseline scenario, the fault is detected in the SCADA-system. After the failure has been detected, the SCADA-engineer calls the local operation teams and passes on the relevant information. In case of a regional outage, the SCADA-engineer has to trigger further workmen and to pass on the information according to RWE’s emergency manual.

Led by the SCADA-engineer, the worker of the operation team has to drive to the secondary substation which is located in the middle of the faulty line. From this substation the employee drives to other affected substations to analyse the short circuit indicators to enclose the fault until the affected line is localized. When a visual inspection is not effective to find the cause of the outage, the cable test van will be requested.

During and after localising the fault, the SCADA-engineer is responsible to coordinate the restoration of supply of the not affected customers in cooperation with the operational employee. Therefore, the faulty cable or overhead power line or secondary substation is isolated from the rest of the grid. The non-faulty parts of the grid are then reconnected, either via remote-control by the SCADA-engineer (for the feeder bays in the primary substations) or manually by the operation worker (for the secondary substations).

Failure management with MAS

When an autonomous switching system is installed (smart grid scenario), the restoration of supply will be more efficient and the downtime should be shorter. The procedure is described in the following:

When a fault has been detected in the SCADA-system, the autonomous switching system localises the faulty line sector autonomously by analysing the short circuit indicators. Then the autonomous switching system separates the grid sector with the faulty cable or overhead line and reconnects the non-affected line sectors automatically to the grid. This takes only a few minutes so that more customers are resupplied in an instant than in the baseline scenario.

Meanwhile, the same working procedure as in the baseline scenario takes place as the SCADA-engineer informs the worker of the operation team about the failure in the grid. The advantage of the autonomous switching system for this working step is that the operation worker receives more precise information about the location of the fault. He can drive directly to the faulty grid section and start with the analyses of the short circuit indicators there. Thus, the operation worker is faster in identifying the faulty line.

In order to reinstall the supply for the customers in the faulty grid sector, the operation worker drives to the faulty line and separates the line sector from both sides. This also takes place faster because he is supported in the switching actions by the SCADA-engineer who executes the remote-controlled secondary substations.

As described, the time for the detection and identification of the outage as well as the outage time for customers in the non-faulty grid segments can be decreased significantly.

Result of the simulations of Demo1

The results for the improvement of the failure management can only be retrieved by simulations and test in the laboratory tests as no outage occurred in the demonstration area during the project time.

The simulations of three different events of fault indicated that the autonomous switching system improves the security of supply in the demonstration area and is able to reduce the time of reconfiguration by 21.5% on average. The three simulations were two three-pole-short-circuits and one two-pole-short-circuit on cables or overhead lines.

This result is supported by simulations that were done with the help of a grid calculation program. The simulation for failure detection, isolation and restoration showed that the higher level of automation leads to an improved security of supply. You can find the calculated values for SAIDI and ASIDI in the following table.

Situation	SAIDI in min/a	ASIDI in min/a
State of today	12,8	14,9
System applied	6,1	7,5

Table- 5 - simulated impacts of the autonomous switching system on the security of supply