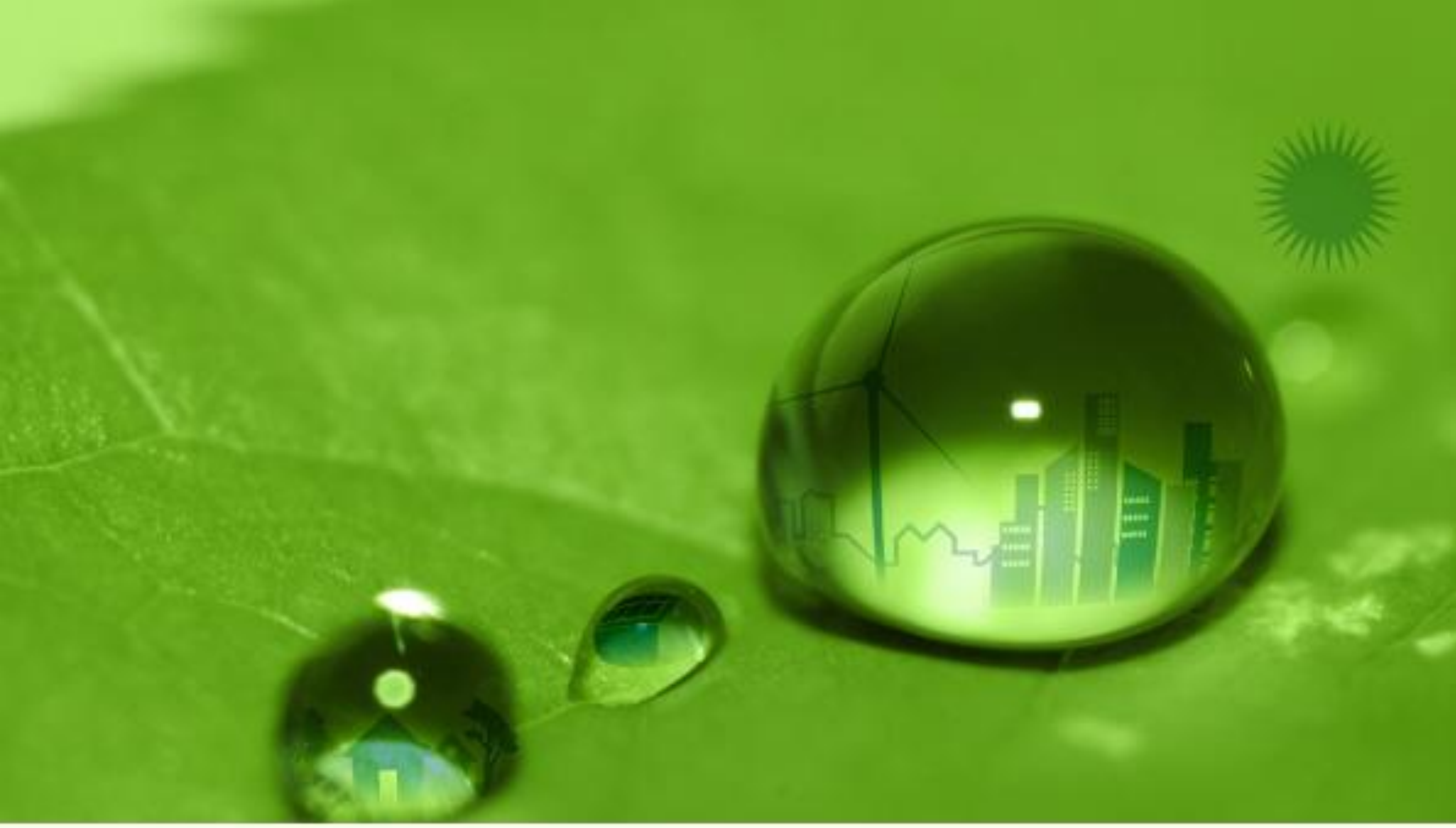

GRID4EU

INNOVATION FOR ENERGY NETWORKS

Technical Spotlight DEMO3-1

Spotlight on Automatic Grid Recovery implemented in DEMO3

CO - FUNDED BY THE EUROPEAN UNION

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• Accessibility

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Table of content

1 Introduction

1.1 Scope

This document summarizes the work carried out related to the implementation of the Automatic Grid Recovery system within the framework of DEMO3. First the initial objectives and technical requirements are introduced, then a brief overview of the algorithm is presented. Finally the main results and lesson learned are given.

1.2 Tags & metadata (Technical Glossary)

<table>
<tr><th colspan="5">Type of solution</th></tr>
<tr><td colspan="5">☐ Equipment / Hardware / Firmware ☐ Information system ☒ Process</td></tr>
<tr><th colspan="5">Manufacturer(s) implied (for equipment or hardware)</th></tr>
<tr><td colspan="5"></td></tr>
<tr><th colspan="5">Work Stream considered</th></tr>
<tr><td colspan="5">☐ Active Demand ☐ DER ☐ Storage ☐ Islanding ☒ MV Innovation ☐ LV Innovation</td></tr>
<tr><th colspan="5">Location / Topology (with regards to distribution grid)</th></tr>
<tr><td colspan="5">☐ HV/MV Substation ☐ MV ☐ MV/LV SS ☐ LV ☐ DER ☐ Meter ☐ Downstream meter
☒ Other Centralized system (calculations, information system) ☐ Other Decentralized ☐ Other :</td></tr>
<tr><th colspan="5">Thematic(s)</th></tr>
<tr><td colspan="5">☐ Grid Monitoring / state estimation ☐ Active demand / DSM ☐ DER Integration / increased grid capacity
☐ Islanding ☐ Anti Islanding protection ☒ Automatic Failure Detection ☒ Remote Grid Operations
☒ Automatic Failure Management / Grid recovery ☒Automatic Grid topology reconfiguration ☐ Other :</td></tr>
<tr><th colspan="5">Use Case(s)</th></tr>
<tr><td>DEMO 1</td><td colspan="2">☐ Failure Management in MV networks</td><td colspan="2">☐ Decentralized grid operation in MV Networks</td></tr>
<tr><td>DEMO 2</td><td colspan="4">☐Outage detection in the LV Network</td></tr>
<tr><td>DEMO 3</td><td>☒Automatic Grid Recovery (AGR)</td><td>☐Automatic Outage Detection (AOD)</td><td>☐Secondary Substation Node (SSN)</td><td>☐Customer Engagement</td></tr>
<tr><td>DEMO 4</td><td>☐Voltage control on MV grids (with high DER penetration)</td><td>☐Anti-islanding protection on MV grids</td><td>☐MV Measurement acquisition</td><td>☐Demand response for MV Customers</td></tr>
<tr><td>DEMO 5</td><td>☐MV grid automation of failure management</td><td colspan="2">☐LV grid automation of failure management</td><td>☐Management of islanding operations</td></tr>
<tr><td>DEMO 6</td><td>☐Islanding</td><td>☐Reduction of power demand</td><td>☐Manage maximised PV production on LV network regarding constraints and flexibility programs</td><td>☐Encourage resident to adopt smarter habits according to network state</td></tr>
<tr><th colspan="5">Key figures</th></tr>
<tr><td colspan="5">e.g. Installed capacity, Number of customer impacted, number of MV/LV substations impacted etc.</td></tr>
</table>

2 Objective and technical requirements

2.1 Context & Objective

Traditionally, when a definitive trip appears in the MV grid, the dispatcher operates the grid manually in order to isolate the fault and recover as much market as possible. The dispatcher interprets all the alarm sent from the monitoring devices and protection allocated in the grid, and based on its current state (i.e. situation of load, topology, etc), the dispatcher manipulates the remote terminals to reconfigure the MV grid and thus isolating the fault and restoring the service where it is possible providing an alternative topology of the grid.
In complex situations the operation of the grid is cumbersome. The amount of variables that the dispatcher has to analyze and the multiple operations that he has to perform constraint the restoration time of the service affecting primarily the quality of service.
The spirit of the Automatic Grid Recovery system is to improve the restoration time. It analyses all the information coming from the grid (state, topology, alarms, etc), generates an operation sequence and actuates on the corresponding remote controlled switches autonomously to reconfigure the grid, isolating the fault and recovering as much market as possible in the shortest time.

2.2 Requirements

The Automatic Grid Recovery system is a watchdog program integrated in the SCADA system from SIEMENS (Spectrum).
The AGR works on the existing remotely controlled switching infrastructure.

3 Development and implementation

3.1 Architecture and technical characteristics

The Automatic Grid Recovery (AGR) is located somewhere between the message processing, the topology evaluation and the network control. The message processing supplies the triggers and the tags. The topology evaluation supplies the connectivity, topological searches (look for feeder-head, etc.) and generates lists of affected equipment and possible switching elements. The network control is the mean to execute the evaluated switching operations.

The operation of the AGR is triggered by a “Definitive Trip”, when a fault within a feeder causes the feeder head circuit breaker to open. The AGR calculates the affected domain and takes control of it, disabling all local automatisms and warning the dispatchers at the same time. It analyzes the information coming from the SCADA system (including Fault Detectors information if available); triggers first an isolation sequence, and then the restoration process from neighboring Feeders Heads whenever is feasible. Finally AGR tags the affected segment and inform the dispatcher.

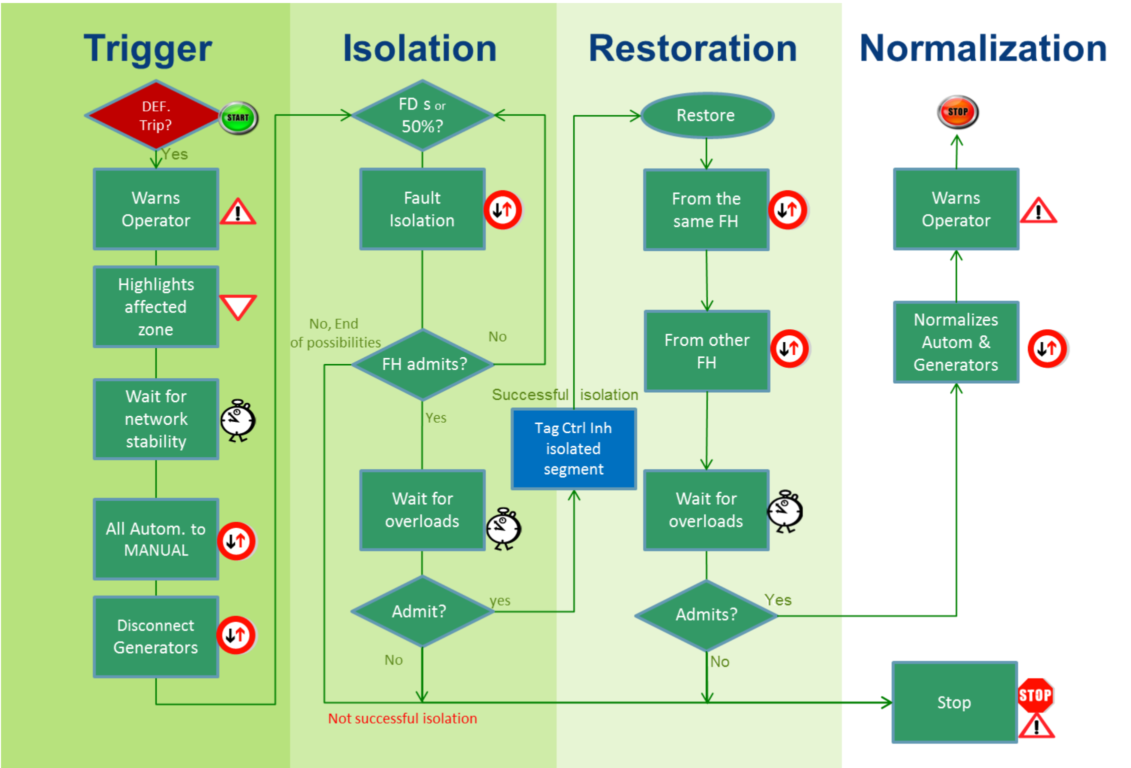

Figure 1. Automatic Grid Recovery basic algorithm.

3.2 Lab tests

Not Available.

3.3 Field implementation

The AGR was first implemented in the MV grid of Castellón, composed of almost 40 primary substation, nearly 600 secondary substation distributing energy to more than 100,000 customers, in a progressive process.

Nowadays the AGR is implemented on all the MV grid of IBERDROLA at Spain, organized in 6 Systems - covering around 1000 substations (100% remotely controlled), 100.000 secondary substations (13% remotely controlled), 3500 of pole mounted RTUs to supply nearly 12 million customers.

4 Technical results

The AGR has dramatically changed the way IBERDROLA operates its distribution networks as it is the first time that automatic controls are sent from the control system in a closed loop scheme. The Control system provides the dispatcher the faulty segment isolated instead of analyzing a number of alarms as in the classical approach.

4.1 First field results

In a detailed analysis at Castellón during 4 months the system acted 34 times. In 18 cases the problem was completely solved recovering 100% of the affected grid. In 17 of these 18 cases the recovery time was under the legal penalty limit (3 minutes) with an average time of one minute and a half (1:31). Only in one case the resolution time was over the limit with 3:05 minutes.

Recover 100% < 3 minutes	Recover 100% >3minutes	Isolation	
17	1	16	
Average Restoration time	**Maximum Restoration time**	**Average Isolation time**	**Maximum Isolation time**
1:31 minutes	3:05 minutes	1:05 minutes	2:03 minutes

Figure 2 AGR results from Castellón

The other 16 cases finished with a part of the grid service recovered and the faulty segment isolated in an average time of 1:05 minutes.

4.2 Final implementation and results

The system has been implemented on all Control Centres at IBERDROLA Distribution Spain (organized in 6 Systems) covering from the VHV to LV in each area, this is, around 1000 substations (100% remotely controlled), 100.000 secondary substations (13% remotely controlled), 3500 of pole mounted RTUs to supply nearly 12 million customers.

Iberdrola has extended this system to the whole distribution network in Spain without the need for an intensive investment at substation level (local approach), so the virtual operator has been introduced without relevant changes at field level what constitute an important technical and economic benefit.

Regarding to quality of service, Iberdrola has verified an improvement in restoration time within the set of faults which recovery time is in the interval from 30 seconds to 45 minutes. AGR stands for an improvement of 8% in faults below 3 minutes. The percentage has been calculated using the not supplied energy comparing one year when AGR was not integrated and the values from a year with AGR working in the distribution network.

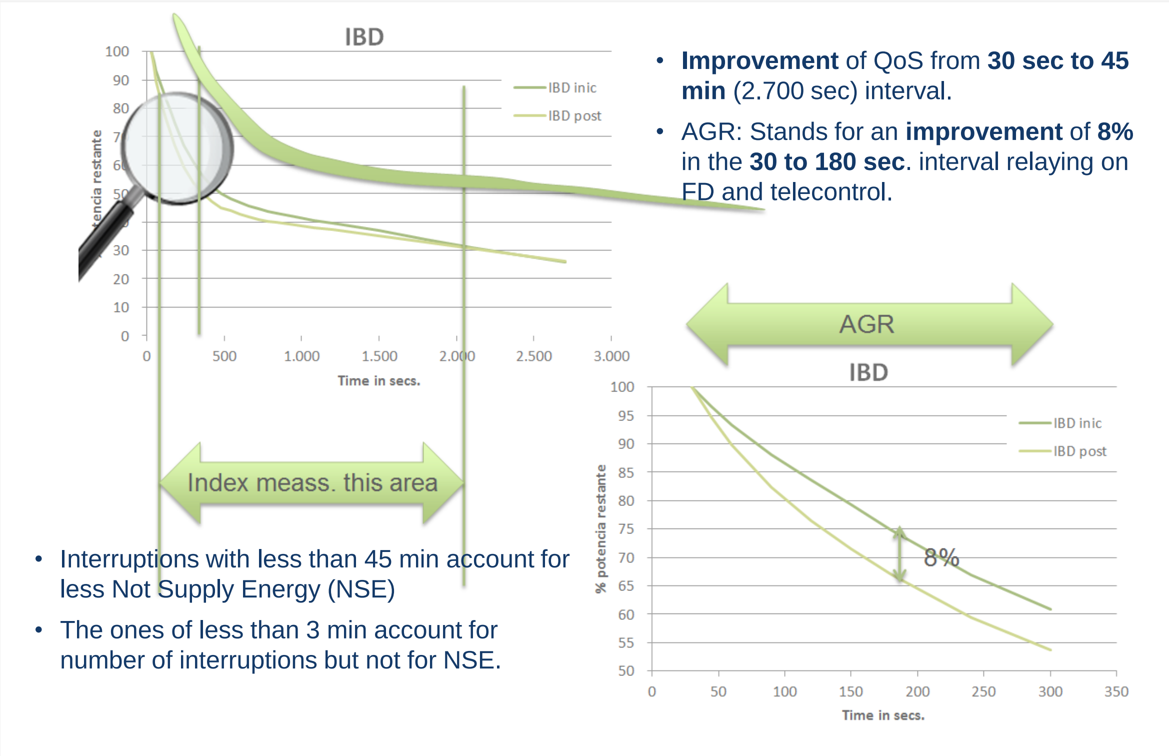

Figure 3 AGR global results

5 Elements of Cost & Benefits Analysis

Not Available.

6 Replication, next steps and up scaling

The Automatic Grid Recovery system has been already deployed in the grid of Iberdrola at Spain. It is now a reality and it fosters to think on the implementation of new automatic operations and replications in USA and UK.

7 Intellectual property (IP)

Not Available.

8 Regulatory challenges

No regulatory barriers foreseen.

9 Conclusion and key messages

The AGR reduces the resolution time of faults in the range between 30 second - 45 minutes. It recovers the market faster than the dispatcher.
AGR makes life easier to Dispatcher, reducing their stress and let them concentrate on leading and coordinating field teams to solve the outages.

10 Appendix