European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out

TRANSNATIONAL ACCESS
USER PROJECT FACT SHEET

USER PROJECT	
Acronym	**DEFINIT**
Title	**DE**centralized **F**ault **I**de**N**t**I**fica**T**ion for distribution grids using a limited number of measurements of LV voltage and current and MV current
ERIGrid Reference	**654113**
TA Call No.	**4th Call**

HOST RESEARCH INFRASTRUCTURE			
Name	**PNDC, University of Strathclyde**		
Country	**UK**		
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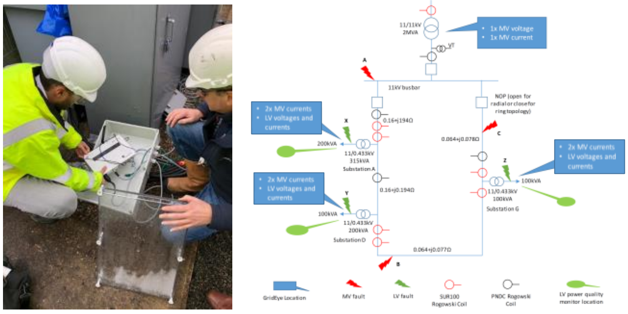
1. USER PROJECT SUMMARY (objectives, set-up, methodology, approach, motivation)

This project aims at testing the capability of GridEye measurements and algorithms for fault identification in distribution grids. The decentralized fault identification algorithms use a limited number of measurements to identify different types of faults in distribution grids. The fault identifications algorithms integrated in the GridEye system allows utilities to deploy a unified solution for observability, control, and fault management in their distribution grids. This will effectively improve the security of supply by decreasing the average outage duration for each end-customer which consequently increases the end-customers satisfaction.



Left) GridEye installation, *Right*) test network configuration.

Four GridEye cells are installed in the network measuring voltages and currents in the MV and LV network. The available sensors and equipment in the network are also used to collect further measurement data and to compare the measurement data. A comprehensive set of tests are carried out focusing on the verification of fault identification functions for MV faults and LV faults at different locations and in different loading profiles and different MV grid configuration (radial and ring). In order to replicate various phenomena and operating conditions occurring in distribution grid which are not faults, but they might be wrongly identified as faulty states, other tests are carried out including load variation and transformer inrush current. Every test has been repeated three times and the measurement data are collected. The performed tests are summarized in the shown table.

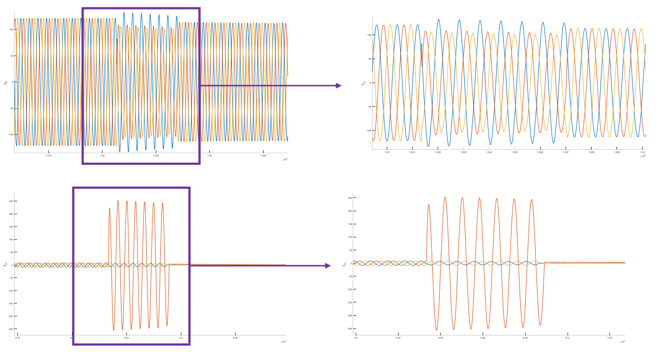
Test category	Tests applied
MV faults	• Fault location: A, B & C. • Fault type: L1-G (R_f = 20 Ω), L1-L2 (R_f = 60 Ω), L1-L2-L3-G (R_{f1-3} = 150 Ω, R_{fg} = 20 Ω) Each fault type will be repeated three times at each location. The fault scenarios will be applied for radial and ring network configurations.
LV faults	• Fault location: X, Y & Z applied at LV test bays downstream of the substation LV output. • Fault type: L1-G (R_f = 0 Ω), L1-L2 (R_f = 0 Ω), L1-L2-L3-G (R_f = 0 Ω). Each fault type will be repeated three times at each location.
Loading conditions	• Reduction of total load by 20 kW steps to 0 kW. • Increase of total load by 20 kW steps from 0 kW to maximum loading. • Apply a power factor of 0.9 to the total load. The above loading scenarios will be repeated for radial and ring network configurations. • Apply a single-phase load of 30 kW to substation A, while three-phase loads of 80 kW are applied to substations D & G.
Transformer inrush	Close MV circuit breaker at the primary substation to energise the test network while substation transformers A, D & G are connected.

The GridEye measurements from the thrown faults are used to primarily evaluate the performance of GridEye's fault identification algorithms for determining the type and location of faults and also for possible improvements of the algorithms.

The realization of this project allowed testing and improving the performance of fault identification algorithms of the GridEye system. The GridEye system with its accurate fault identification application will be a suitable solution for electrical utilities and will effectively avoid the need for a dedicated device for fault identification and its related installation costs and difficulties. It will facilitate the use of such a fault identification solution in distribution grids and eventually enhances the security of supply and SAIDI.

2. MAIN ACHIEVEMENTS (results, conclusions, lessons learned)

The performed tests have allowed to collect measurements data when different types of faults (earth fault, 2-phase fault, 3-phase fault) occurring in MV and LV grids, resembling various real grid operating conditions and configurations. Examples of earth fault measurements are given in the figure.


Examples of measurements for earth faults.

These measurement data has allowed us to validate the fault identification algorithms. It has eventually helped us to accelerate the time-to-market for the fault identification application.

This has been achieved by having access to excellent facilities with direct support and recommendation of expert personnel, allowing to timely conclude several tests.

3. PLANNED DISSEMINATION OF RESULTS (journals, conferences, others)

It is planned to prepare a white paper for DEPsys website. We are evaluating the possibility to file a patent.