gD3.4 Results of the simulations carried out in the SRA for all demos

Abstract

Deliverable gD3.4 presents the technical scalability and replicability analysis (SRA) of the different use cases included in the GRID4EU project.

The aim of GRID4EU SRA is to learn from the smart grid solutions tested in the Demonstrators and evaluate the implications of their implementation at a larger scale or in a different context. The SRA comprises two main stages, namely, a technical analysis to assess the effect of technical boundary conditions, and a general analysis focused on the non-technical boundary conditions, which include regulation and the perspectives of the different stakeholders involved, to identify the most favourable conditions and potential barriers for the implementation of GRID4EU use cases.

Technical scalability and replicability analysis (SRA) is focused on the evaluation of different technical boundary conditions to understand the implications on the outcomes of scaling-up and replicating the implementation of GRID4EU smart grid use cases at a larger scope (scaling-up) or in a different context (replication). Deliverable gD3.4 presents the work carried out during Year 4 for the technical SRA of the use cases tested in the Demos of the GRID4EU project.

Building up on the methodological framework and the analysis of the technical boundary conditions in the Demo countries presented in previous deliverables (gD3.1, gD3.2&3.3), technical SRA relies on simulation using representative[1] networks to compute the Key Performance Indicators (KPIs). According to the pursued objectives and type of electrical simulations for technical SRA, use cases were grouped into three categories: use cases that will be subject to network reliability analysis, steady-state analysis, and dynamic analysis. This document describes in detail the simulation models and tools used for each block of use cases, as well as the simulation scenarios considered to cover the relevant technical boundary conditions.

The four use cases grouped for distribution network reliability analysis aim to improve continuity of supply through the implementation of automation, fault detection systems and remote control of switching elements. The effect of these use cases has been studied together, using a set of 10 representative networks. Reliability indices have been computed to determine the improvement achieved by different degrees of implementation of automation. Simulation has covered network architectures for different distribution areas, variances in the response times of smart grid solutions implemented by the Demos, sensitivity to technical network characteristics including length and failure rate, medium and low voltage levels and the use of different reliability indices. This document also discusses automation of the distribution network for the improvement of continuity of supply, (i) clarifying the main terms and elements involved, (ii) describing the process for fault management and service restoration in actual distribution networks and (iii) explaining the effect of automation on this process.

The use cases grouped for steady-state analysis aim to improve quality of supply, avoiding

[1] The selected networks are relevant and complementary for the tested use cases, but do not constitute a fully exhaustive set and no representativity rates are assigned to each network within each DSO or demo country.

overloads and overvoltages in the networks, to enable efficient integration of distributed energy resources (DER) integration. These use cases implement smart grid solutions based on the use of different elements (demand side management, energy storage, reactive power output of distributed generation or network reconfiguration), with a direct impact on voltage profiles, power flows and losses. Simulation for technical SRA for these use cases consists in load-flow analysis for different scenarios that can account for the different strategies and solutions implemented in each use case to determine network hosting capacity. Each type of use case has been analysed separately to address the different DER involved, using representative networks modelling low and medium voltage, and mono- and tri-phase networks.

The use cases grouped for dynamic or time-domain analysis are related to intentional or un-intentional islanded operation of the distribution network. The objective of islanding use cases is to provide an alternative to supply distribution areas in the event of emergency situations, while the anti-islanding use case aims to avoid uncontrolled operation situations. Simulation of technical SRA has evaluated the behavior of the island at the moment of disconnection from the grid and islanded operation to identify successful and sustained islanding. The three use cases have been separately analyzed based on specifically designed network models including cogeneration, storage and photovoltaics.

This report presents the major results obtained from the technical SRA as well as the generalization SRA rules that can be derived from these results, placing a strong emphasis on comparisons across use cases with similar goals. SRA rules will allow DSOs to perform a preliminary assessment of the expected results for the adoption of a specific smart grid solution or allow decision-makers to make better informed decisions on roll-out plans. Additionally, the lessons learnt when developing and applying a SRA methodology can help future researcher groups to perform similar analyses to other use cases or functionalities.