



UE Project N. 261788

Assessment framework and tools to identify vulnerabilities of energy grids and energy plants and to protect them against cascading effects

Project context and objectives

AFTER project aims at increasing the TSO capabilities in creating, monitoring and managing secure interconnected electrical power system infrastructures, being able to survive major failures and to efficiently restore service supply after major disruptions.

AFTER project Objectives

- to develop a framework for risk and vulnerability assessment of the interconnected power system considering both natural and manmade, (Power System and ICT) failures
- to introduce innovative defence plan concepts and techniques to manage multiple contingencies and assessment methodologies, to assess their effectiveness
- to develop innovative restorative control by designing a framework to support the restoration stages of the integrated power systems considering multiple contingencies

Project objectives will be met with the definition of a framework, methodologies, tools and techniques, in particular for:

- to assess the risk (hazard, vulnerability and impact analysis) of the interconnected and integrated electrical power and ICT systems;
- to evaluate and to enhance the security and resilience of complex energy systems;
- to design and assess of global defence and restoration plans.

The development of AFTER framework will requires:

- the analysis of threats, vulnerabilities, failures of different component and (sub-)systems and the identification of models of the dependency of the power system from the ICT systems
- the definition of appropriate risk assessment methods and risk indices
- the definition of physical security methods and techniques
- the definition of criteria and techniques for defence and restoration.

Work performed and main achieved results

In the second period the main activities concerned:

- the specification of a set of test cases for the development and the evaluation of AFTER methodology and tools (T4.1 and T4.3, T5.1, T7.3, T8.1)
- the definition of a computer method for event analysis and of a computer demonstration of the sensor applications to physical security measures of physical security criticalities and attach scenarios and into energy system facilities including substations. The emphasis has been put on acts of terrorism, sabotage, criminal activity and malicious behaviours. (Wp3, T3.3 and T3.4)
- the definition of the AFTER methodology for power and ICT the vulnerability identification and risk assessment, contingency planning methodology (Wp4 T4.1 and T4.2)
- the specification of risk assessment tool (Wp5, T5.1 and T5.2)
- the technical specification of components for Wide Area Protection and the development of concepts for automated decision making based on distributed intelligent devices (T6.1 and T6.2)
- Decision support systems the identification intelligent reconfiguration options (T7.2)

The following main results have been obtained:

- the models for the risk assessment taking into account several kind of relevant threats (physical and human related) for power system operation and considering uncertainties.
- the specification of the risk AFTER assessment tool
- the definition of wide are protection functionalities based on decision support techniques
- the specification of a decision support systems the identification intelligent reconfiguration options

AFTER project impacts

AFTER project will have relevant impacts on the security and resilience of complex interconnected energy networks: increased exploitation of the transmission grid, reduction of blackout occurrence, extension, and duration. This impact relies on the main results of AFTER, i.e. the combined analysis of the integrated power and ICT infrastructures and the risk-based approach to security. Both of them overcome the methodologies and practices currently adopted by TSOs.

Further, AFTER approach to security assessment of power networks will cause a leap in European industrial know-how and competitiveness and result in a competitive edge in knowledge and technology for network operation and industry in Europe. In particular, the Power System industry will be able to develop a new generation of **EMS functions** based on integrated risk analysis. Similar **tools** will be proposed to support (operational-) planning activities. Besides products, significant **engineering and consultancy services** can arise from the expertise gained with AFTER, related to integrated power and ICT system vulnerability analyses, defence plan design, etc.

AFTER will impact on the activity of analysts, planners, operational planners, control centre operators, power system and communications engineers. AFTER results will enhance their capability to design and operate more dependable systems by providing better insights into the problems and easier ways to analyse architectural, functional, and operational solutions.

Besides developing new integrated methodologies also with the contribution of TSOs, AFTER will contribute to make the results be accepted by the users.

Furthermore, AFTER results will enhance the confidence in the integrated, risk based approaches to system analysis and contingency planning to reduce security gaps. The project will enforce long-term future collaboration even after ending of the project enforcing the practical application of project results as well as its integration in national and international standards.

AFTER project consortium

AFTER consortium, under the coordination of Ricerca sul Sistema Energetico (RSE) combine a well-balanced team of experts in subjects from advanced research in power systems, to application-oriented industrial research, and important European Transmission System Operators.

Excellence and expertise are guaranteed by:

- the most important electrical energy research centres in Italy (Ricerca sul Sistema Energetico - *RSE*) and in Norway (SINTEF), *the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)*
- some of the most renowned and active Universities in Europe (University College of Dublin - UCD, City University of London and University of Genoa)
- two European leading Industries in the field of power systems and of both power and ICT equipment (ALSTOM and SIEMENS)
- three important European TSOs (CEPS, ELIA and TERNA)

AFTER project website

<http://www.after-project.eu/>

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