Project no.:
608540

Project acronym:
GARPUR

Project full title:
Generally Accepted Reliability Principle with Uncertainty modelling and through probabilistic Risk assessment

Collaborative project

FP7-ENERGY-2013-1

Start date of project: 2013-09-01
Duration: 4 years

Public Summary of D8.2 Results from pilot testing using the quantification platform prototype

Due delivery date: 2017-09-31
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Organisation name of lead beneficiary for this deliverable:
RTE

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

General Summary

The GARPUR Project proposes a new family of Reliability Management Approaches and Criteria (RMAC), for use in various contexts of Transmission System planning, asset management, and operation.

The pilot test covers short-term operation on the south-eastern part of the French grid. It is based on the GARPUR quantification platform (GQP) and aims to compare different reliability management criteria.

Four reliability management criteria have been tested by using the GQP prototype, namely the N-0, strictly preventive N-1, a first GARPUR RMAC implementation considering only N-1 contingencies, and a second GARPUR RMAC implementation considering some N-2 in addition to the N-1 contingencies.

Complementary sensitivity analyses have been performed on the main input parameters, to observe which ones were those having the most influence for each of the 4 RMACs that have been tested.

The results obtained during this pilot test seem to comfort the idea that a probabilistic RMAC as developed in WP2 should enable to reach a similar reliability level as today at a lesser cost. However, because of the modelling assumptions that were necessary to perform the test, and because the reactive/dynamic phenomena were not considered, some precautions should be taken regarding the validity of these results.

Among the topics that we believe should be priorities for future work to transform this research grade prototype into an industrial tool, we would like to underline:

- The automatic finding of corrective actions, especially when several topological actions are involved,
- The modelling of the consequences of contingencies, in particular to relax the assumption that a malfunctioning corrective action would result in a blackout,
- The tuning of the values of the probabilities of corrective control failures, which were seen to have a strong influence on the final results.

The research leading to these results has received funding from the European Union
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RTE pilot test

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Time frame: Short-term.
Period of Assessment: 1 year.
Assessment type: Reliability assessment, comparison of four different reliability management criteria and sensitivity analysis to reliability input information.

The pilot test performed by RTE, the French Transmission System Operator, aims to compare different reliability criteria in terms of their induced socio-economic consequences by using the GARPUR Quantification Platform (GQP) prototype. This case study is meant as an illustrative example of using the GARPUR probabilistic reliability methodology on a real TSO power system, targeting day-ahead operation planning and real-time operation.

This pilot test assessed the GARPUR methodology on the south-eastern part of the French grid system using past 2013 DACF and EMS live system state data. The GQP consists of several modules and simulates one-day-ahead operational planning, real time operation with possible contingencies, preventive and corrective actions. It is implemented in Matlab; the SCOPF based on CPLEX solver is interfaced with the AMPL modeller.

The general framework of the test is decomposed in three implementation stages:

- Stage 1: Day-ahead preventive stage
  The first stage aims to determine the decisions performed by the TSO in day-ahead consistently with the RMAC that it has adopted. A single DACF is considered for the decision making at this stage. Based on this forecast, and depending on the RMAC under consideration, a set of day-ahead preventive actions are decided for reliability management and are committed for the next day.
- Stage 2: Real-time preventive stage
  The next stage consists in modelling the intraday operation prior to the occurrence of any contingency. Here, about 100 samples are drawn to represent possible deviations from the abovementioned forecast. Each sample embeds the decisions committed at the previous stage (day-ahead). For each sample, a set of real-time preventive actions are decided and committed.
- Stage 3: Real-time corrective stage
  Finally, in the last stage the response of the system for a given set of contingencies is simulated. In particular, the corrective control and its probability of failure are considered. This stage is neutral with respect to the RMAC used by the TSO, as we only witness the behavior of the system and there are no longer decisions to be made.

In the case of this test on the RTE network, the RMACs behaviours are consistent with intuitions. A strictly preventive N-1 implementation is, as expected, costlier than a RMAC tolerating a non-null reliability target, and this for a very small difference in terms of reliability and control of the residual risk. Similarly, stacking N-k (k>1) contingencies in the RMAC could twist the preventive solution at a higher cost with little gain in terms of reliability, which is not optimal from a socio-economic point-of-view. When raising the failure rate probabilities, the RMAC dealing with N-1 contingencies tends to mimic the strictly preventive N-1 implementation, which confirms that high preventive costs could be justified in case of difficult operational conditions.

However, those RMACs that were tested for this pilot test are not fully consistent with WP2, as the

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reliability target and the discarding principle were not implemented. If the time and resources had allowed, they would have been interesting to consider. Ideally, it would have also been interesting to consider the temporal correlations in the simulation.

While running the tests and understanding the behaviour of the GQP, we raised the following modelling issues:

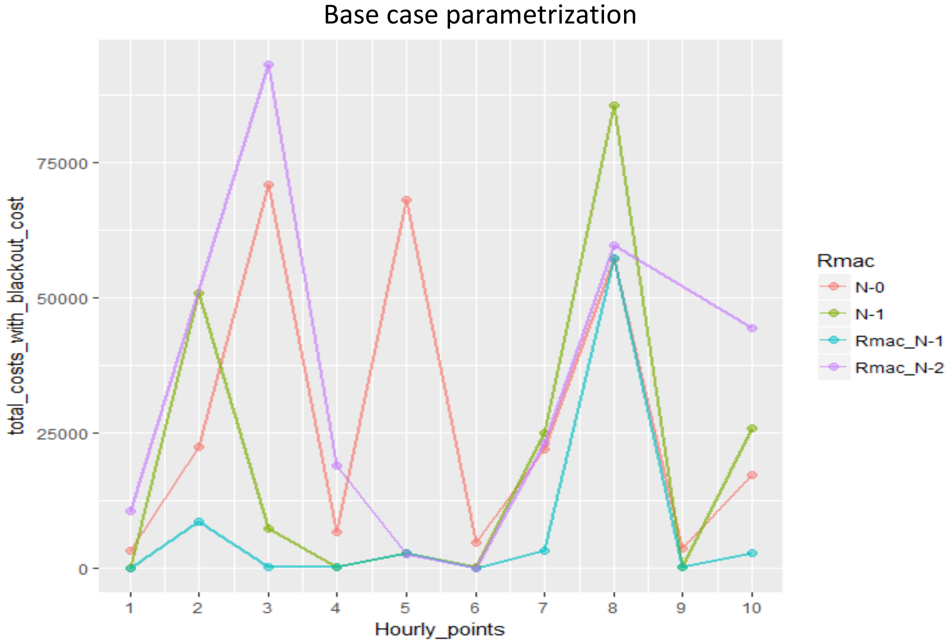
- The selection of the corrective actions is of utmost importance, and unfortunately is very difficult to model. Indeed, the recourse to corrective action is situational, and sometimes it is necessary to involve a combination of several means, including topological actions. The algorithms that we have today struggle with this task.
- The assumption that any failure of corrective action or load-flow divergence would end up in a blackout is too strong to be meaningful. It gives too much weight to the parameter "probability of failure of the corrective action". Overall, there is a strong need to progress on the assessment of the consequences of a contingency.

In addition, to compute indicators that would be accepted by the TSO operators, an improved version of the GQP should be able to work in AC instead of DC, which adds a new layer of difficulty on top of the current implementation.

Besides, the whole test was hindered by the limited performances of the GQP. This is understandable given this prototype is a research-grade software developed in a very short amount of time. Improving the performances should be a top priority for the further development of a GQP. It means in particular:

- Using a much more powerful hardware,
- Recoding the GQP with a faster language and by using faster external libraries

At last, given the GQP is the first tool of its kind, its validation is particularly difficult. It can only be achieved by a strong collaboration between the developers and the operators who know how the power system behaves. Adding a graphical interface would be necessary. The question on how to display the outcome of the probabilistic computation is pending, as already mentioned in previous GARPUR deliverables.



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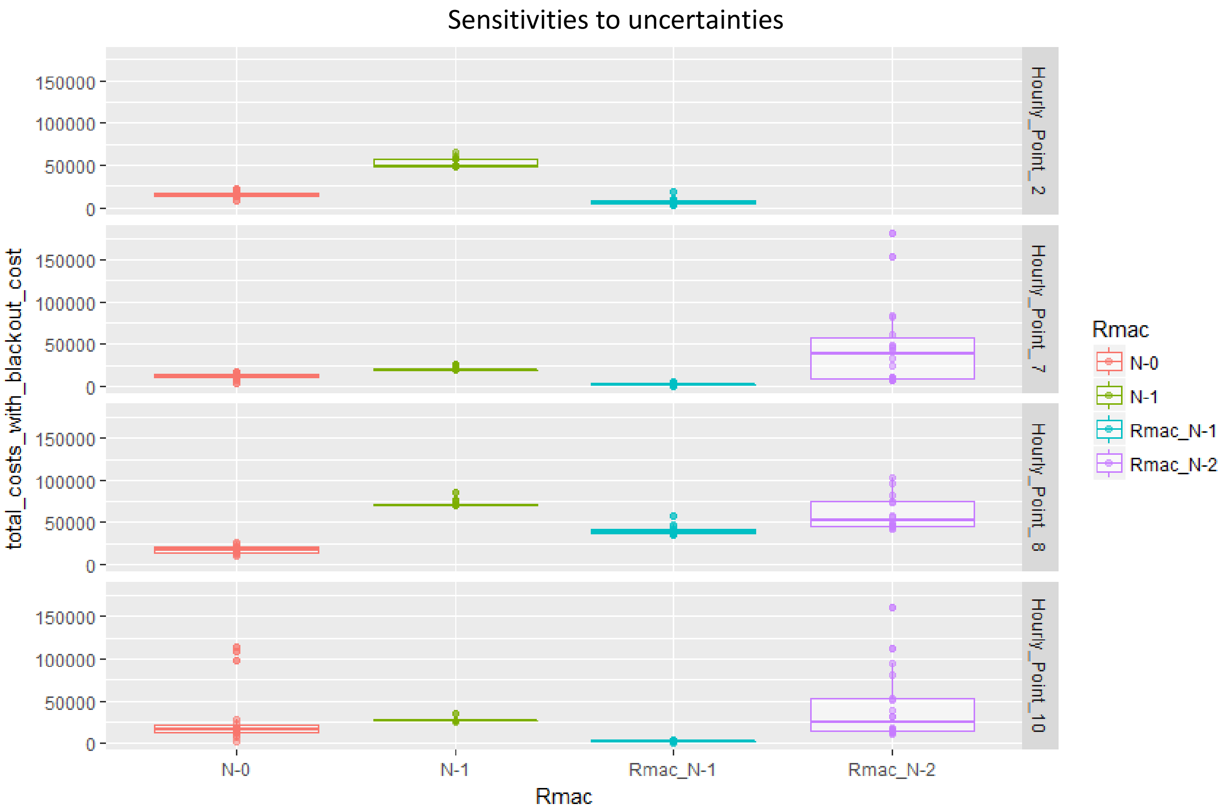

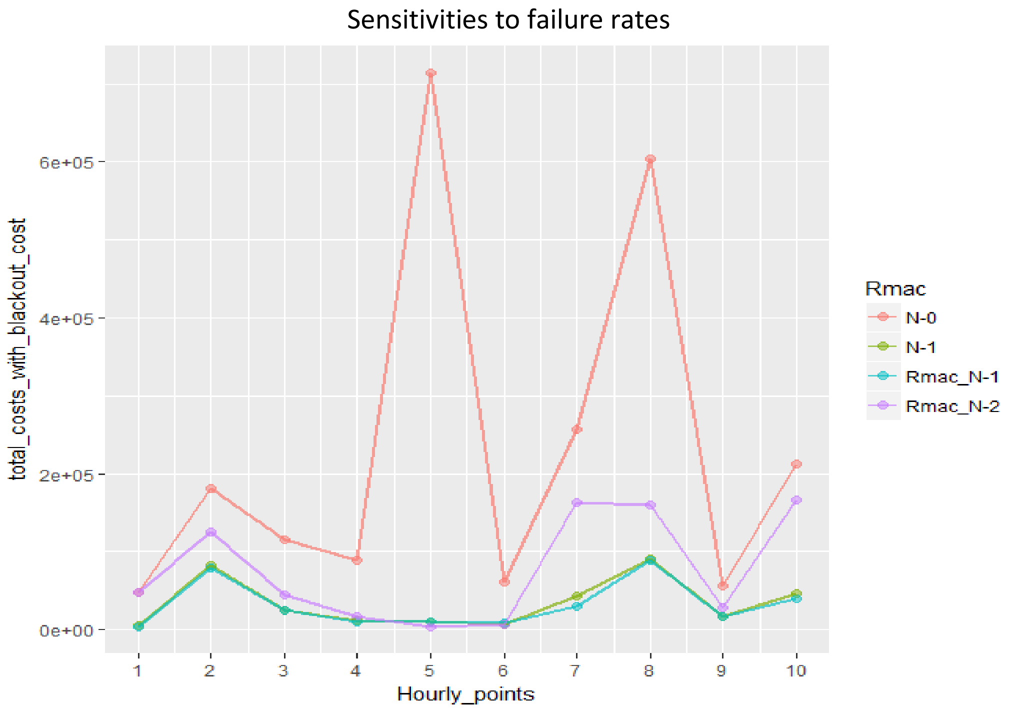

Example of comparison outputs of the RTE pilot test

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