CYPRESS

Modeling for cyber-physical risk assessment

Task 2.1 - Project Report

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Date: September 2024

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Executive Summary

The CYPRESS project aims at developing novel knowledge, methods and tools needed to help ensure the security of supply through the transmission grid, while accounting for the specific nature of cyber-threats and integrating them into a coherent probabilistic risk management approach. It is articulated along three research themes, aiming to develop: i) novel models and benchmarks for computer simulation and laboratory testing of the cyber-physical electric power system security of supply, ii) techniques for assessing the cyber-physical security of electric energy supply, and iii) techniques for enhancing the cyber-physical security of electric energy supply. The project scope falls entirely within the category of "fundamental research" within the meaning of Regulation (EU) No 651/2014 because it is experimental and theoretical work undertaken essentially with a view to acquire new knowledge on the foundations of phenomena or observable facts. The project is not intended to develop commercial tools.

The work presented in this document has been performed in the frame of CYPRESS WP2, titled "Cyber-physical risk assessment of transmission systems". The objective of CYPRESS WP2 is to develop a coherent methodology for the *ex ante* assessment of the cyber physical risks facing the electric power system. The document is the outcome of task T2.1 titled "Modeling for cyber-physical risk assessment". The task was defined with two complementary modeling objectives. Firstly, to address the question of cyber-physical dynamic equivalent models allowing to abstract away smaller or neighbouring parts of a system while studying its behavior from a more global perspective. The precise scope here was to investigate how one could leverage existing approaches that allow to abstract away the physical behavior of the system sub-part in question, so as to also reflect their *cyber*-physical behavior. The second objective was to extend the scope of the physical benchmarks deemed relevant in task T1.3 so as to fit the needs of transmission grid cyber-physical risk assessment.

Chapters 2 and 3 relate to the first objective, namely the development of cyber-physical dynamic equivalent models to represent the behavior of sub-parts of the electric power grid. The work reported in both these chapters focuses specifically in the case of distribution grids. This has been identified by the researchers working in task 2.1 as the most relevant use case for representing external systems in the context of transmission level cyber-physical risk assessment. First, chapter 2 reviews and qualitatively assess different cyber-physical threats that may act on the distribution level of the electric power grid. The point here is to identify cyber threats that may have a noticeable impact as "seen" from the transmission grid. Then, chapter 3 details and demonstrates a chosen approach for the derivation of a simpler equivalent model of a distribution grid, on the basis of a corresponding detailed model. This approach could be used to develop alternative equivalent distribution grid models under the threats identified in chapter 2.

Chapter 4 documents the outcome of the effort to extend the scope of the benchmark systems

identified in Task 1.3, so as to fit the needs for cyber-physical risk assessment at the transmission level. It has to be noted that, from the onset of this effort, it was decided not to restrict the scope to the benchmarks identified in Task 1.3. The reason for this was the fact that the available description of such benchmarks was too generic to effectively distinguish them from any other academic benchmark. It was therefore decided to attempt to develop a generic process to extend the scope of any physical power grid benchmark with an inventory of the cyber infrastructure that allows monitoring and controlling the transmission system.

Author contributions

Efthymios Karangelos is the author of chapters 1 and 4 and editor of the report. Frédéric Sabot is the author of chapter 3 and co-editor of this report. Mahdi Bahrami is the author of chapter 2 of this report. Rick Loenders provided valuable comments on an early draft of chapter 4.

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This project is supported by the Belgian Energy Transition Fund