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DESIGN AND DEVELOPMENT OF A CO-SIMULATION PLATFORM FOR MULTI-ENERGY SYSTEM ANALYSIS

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Abstract *Multi-Energy Systems (MES) are complex systems where heterogenous energy vectors (e.g. electricity, heat exchanging fluids, natural gas) interact together in such a multi-faceted way that they are very difficult to be analysed comprehensively. Starting from a literature analysis, we identified the main challenges to be addressed to analyse in-depth these systems and let them interoperate in an efficient interconnection: i) the multi-fuel perspective to analyse the different input that a MES requires, ii) the multi-service perspective to identify the output of MES operations, iii) the multi-scale perspective to scale the analysis from small environments up to large scale scenarios (e.g. house, district, city, region, state), iv) the multi-time perspective to harmonize and synchronize different operational timings, v) the energy network perspective to take into account different vector's distribution and transmission systems, vi) the ICT perspective to monitor and manage the overall system through data signalling, and vii) the economic and business perspective to study the impact of new solutions and services on the marketplace. These perspectives reflect on the difficult effort needed to simulate MES to assess their efficiency from an operational and planning viewpoint. Standalone solutions have been proposed in literature to analyse and simulate MES. However, these solutions focus only on some of the above-mentioned perspectives. Other solutions are more complete and allows analysis of all the aspects required by MES. Often, these solutions follow a vertical design in different field of technology (e.g. electrical and thermal engineering, distribution and transmission grid management and energy market analysis). Hence, MES scenario developers must dedicate a steep learning curve to master these solutions. In this work, we propose a co-simulation platform to simulate all the above-mentioned perspectives of a MES. The platform will allow to run energy-related simulations of specific elements of a MES, or to combine them in a homogenous simulation environment. The co-simulation platform will offer different functionalities to manage MES simulation, connecting in a plug-and-play fashion different software models, hardware and real-world devices. The functionalities will take into account: i) the scenario generation to design a MES interconnecting different ready-to-use models, ii) the simulation step and time management to manage the simulation of each model in a distributed simulation environment, iii) the exchange of information among different simulators, and iv) the optimization process to reach the best efficiency for a MES scenario.*