Simulation of Smart–Grid Models using Quantization–Based Integration Methods

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Concepts such as **smart grids, distributed generation and micro–generation of energy** are becoming increasingly important as emerging trends in the design, management and control of energy systems. Appropriate modeling and design, efficient management and control strategies of such systems are currently being studied. In this line of research a very important enabling component is efficient and reliable simulation.

However those **energy models are typically large, stiff and exhibiting heavy discontinuities**, and at the same time consist of interconnected multi–domain subsystems encompassing electrical, thermal, and thermo-fluid models. Object-Oriented (O–O) languages such as Modelica are obviously well-suited for the modeling of such systems; **however, traditional state-of-the-art hybrid differential algebraic equation solvers cannot efficiently simulate these systems** especially when their size grows to the order of hundreds, thousands, or even more interconnected units.

The goal of this paper is to show, through a couple of exemplary case studies, that **Quantized State System (QSS) integration methods are ideally suited to solve models of smart grid systems**, as they scale up better than traditional methods with the system size, and provide time savings of several orders of magnitude, while achieving comparable numerical precision.

More specifically, **in both cases QSS methods outperform DASSL (and Runge-Kutta) by more than two orders of magnitude in terms of simulation speed**, while at the same time, achieving a comparable simulation error, as seen in Fig. 1. Furthermore, the **QSS methods scale linearly with system size, while DASSL scales quadratically**.

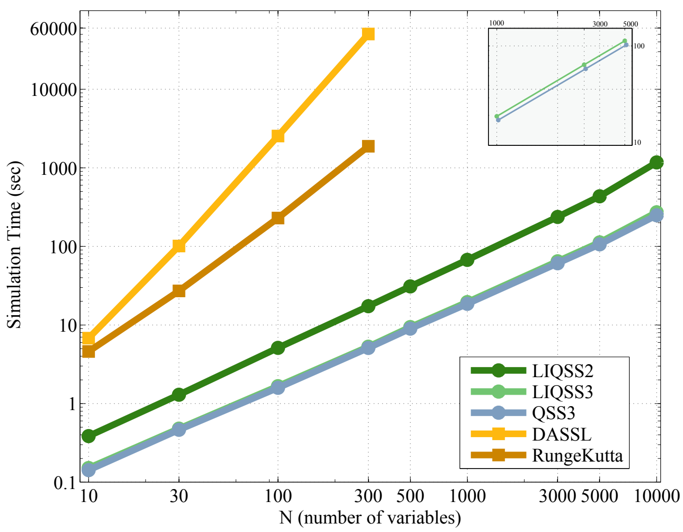

Figure 1: Simulation time for varying size of the Energy Market model. All algorithms achieve a mean error on the order of 10^{-5}.