Continuous Optimal Control Approaches to Microgrid Energy Management

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Abstract

We propose a novel method for the microgrid energy management problem by introducing a continuous-time, rolling horizon formulation. The energy management problem is formulated as a deterministic optimal control problem (OCP). We solve (OCP) with two classical approaches: the direct method, and Bellman's Dynamic Programming Principle (DPP). In both cases we use the optimal control toolbox Bocop for the numerical simulations. For the DPP approach we implement a semi-Lagrangian scheme adapted to handle the optimization of switching times for the on/off modes of the diesel generator. The DPP approach allows for an accurate modeling and is computationally cheap. It finds the global optimum in less than 3 seconds, a cpu time similar to Mixed Integer Linear Programming (MILP) approaches. We achieve this performance by introducing a trick based on the Pontryagin Maximum Principle (PMP). The trick increases the computation speed by several orders and also improves the precision of the solution. The simulations use datasets from an actual microgrid located in northern Chile.