Stochastic dynamic programming applied to microgrid management

Benjamin Heymann

November 27, 2014

Abstract

Energy Management Systems (EMS) are usually based on the integer programming framework. A novel method based on stochastic control and dynamic programming is proposed. It allows for a precise modeling of complex constraints such as the minimal working power of a diesel motor. The EMS proposed here is based on a rolling horizon strategy. It takes into account historical data and randomness as well as the aging of the battery and the motor working constraints. A semi-lagrangian scheme was implemented within BOCOP - a software developed at INRIA - for the numerical simulations. We will compare such method with the one that is currently implemented in a real microgrid in northern Chile. We will also analyse the performance of the software implementation. A practical implementation of the EMS is envisioned. This project is the product of a collaboration between the COMMADS (INRIA, France) and Centro de Energia teams (Universidad de Chile, Chile).

1 Introduction

A microgrid is an electrical network that is disconnected from the main network and is operated autonomously. The model described in the following is based on a real microgrid operated in a village in northern Chile. The village is very isolated and relies completely on the microgrid for its electricity supply. The grid uses a mix of fuel and renewable energy. Compared with technics such as interger programming, the use of stochastic control allows for a dramatic reduction of the computational cost. The grid we are considering consists of a solar panel, a wind turbine, a diesel motor and a battery. Our model aims at finding the optimal operation of those elements that meets the demand. The north of Chile is characterized by a sunny and regular climat. We consider in the model that there is no uncertainty from the production side. On the other hand, the demand will be modeled with a stochastic process. The battery state of health depends on the way it is operated. That's why we will take into account the aging of the battery within the model.