A Stochastic Programming Approach for the Optimal Management of Aggregated Distributed Energy Resources

Patrizia Beraldi Maria Eleana Bruni Antonio Violi Gianluca Carrozzino
Department of Mechanical, Energy and Managment Engineering
University of Calabria, Italy
{patrizia.beraldi,mariaelena.bruni,antonio.violi,gianlucacarrozzino}@unical.it,gmail.com

In the last decades, electricity systems are facing significant changes because of the deployment of information and communication technologies (ICT), power electronics and distributed energy resources (e.g., gasfired distributed generation, solar PV, small wind farms, electric vehicles, energy storage). Unlike centralized generating units, that typically exploit non-renewable sources, distributed energy resource (DER) systems offer the potential to integrate several renewable and non-renewable energy sources and to overcome the disadvantages of the intermittent and unpredictable nature of the renewable supplies and the possible mismatch with the energy demand ([1]). In this new context, it emerges the rule of the aggregator that can be seen as a single entity that manages the resources of the DER systems and interacts with the market so to obtain the maximum benefit from the grid transactions.

In the presentation, we focus on the problem of the optimal management of the distributed energy resources analyzed from the aggregator's perspective. It is called to manage the available resources so to satisfy the aggregated demand over a given time horizon by taking into account the signed bilateral contracts and eventually trading in the spot market.

The main parameters involved in the decision process have clearly an uncertain nature. The required energy demand is typically difficult to exactly predict since it refers to future consumptions. Market prices are known only after all producers and consumers submit their selling and bidding curves, and, thus, they are unknown in advance. Furthermore, the generation from renewable resources can not be accurately predicted because it can depend on the weather conditions.

We deal with this challenging problem by adopting the stochastic programming framework and we propose a two-stage formulation that is embedded within a rolling horizon scheme [2].

Computational experiments have been carried out on test instances designed starting from a real aggregation of prosumers.

The analysis of the numerical results clearly show the effectiveness of the approach as support tool in a real-setting.

References

[1] Muttaqi, K.M. and Le, A.D.T., Aghaei, J., Mahboubi-Moghaddam, E., Negnevitsky, M., Ledwich, G., Optimizing distributed generation parameters through economic feasibility assessment, Applied Energy v. 651, pp.893-90, 2016.

[2] Beraldi, P., Violi, A., Scordino, N., Sorrentino, N., Short-term electricity procurement: A rolling horizon stochastic programming approach, Applied Mathematical Modeling, v. 35, pp.3980-3990, 2011.