

Provision of Ancillary Services by a Smart Microgrid: An OPF Approach

Jose L. Martinez-Ramos¹, Alejandro Marano¹, Salem Al-Agtash², Hossam AbdelHafez², Brian Azzopardi³, Renata Mikalauskiene³, Nis Martensen⁴, Thomas Ackermann⁴, Dimitrios Tzovaras⁵, Dimosthenis Ioannidis⁵, Ahmet Onen⁶, Yeliz Yoldas⁶, Mounir Khia⁷, Lenos Hadjidemetriou⁸, Elias Kyriakides⁸, Tim Camilleri⁹, Nicholas Borg¹⁰

¹ Department of Electrical Engineering, Universidad de Sevilla, Seville, Spain

² Department of Computer Engineering, German Jordanian University, Amman, Jordan

³ Malta College of Arts, Science and Technology (MCAST), Paola, Malta

⁴ Energynautics GmbH, Darmstadt, Germany

⁵ Center for Research and Technology Hellas / Information Technologies Institute, Greece

⁶ Department of Electrical and Electronics Engineering, Abdullah Gul University, Kayseri, Turkey

⁷ Département de génie électrique, ENP d'ORAN, Oran, Algeria

⁸ KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus

⁹ GeoSYS Ltd, San Gwann, Malta

¹⁰ Electronic Systems Design Ltd, San Gwann, Malta

Contact Person: Jose L. Martinez-Ramos (jl.martinez.ramos@gmail.com)

Keywords: Ancillary Services, Microgrids, Optimal Power Flow

SUMMARY

According to the U.S. Department of Energy, “a microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.” Microgrids are an area of extensive research, and standardized solutions that can easily be adapted to all kinds of local conditions of demand requirements and resource availability do not exist yet. In grid-parallel operation, they offer opportunities for resource optimization, especially when facilitating use of renewable energies.

3DMicroGrid is an ERANETMED funded project aiming towards designing and developing a microgrid framework, ideally including a pilot proof of concept implementation at a university campus in Malta or Jordan. The project is a collaborative effort with university and industry partners from Jordan, Malta, Germany, Turkey, Spain, Cyprus, Algeria, and Greece.

“Ancillary services are all services required by the transmission or distribution system operator to enable them to maintain the integrity and stability of the

transmission or distribution system as well as the power quality”. The services include both mandatory services and services subject to competition.

Ancillary services that can be provided by a microgrid are classified according to the operation modes: a) Grid-connected operation (frequency control support, voltage control support, congestion management, reduction of grid losses, and improvement of power quality); b) Islanded operation (black start and grid-forming operation).

The provision of ancillary services in grid-connected mode is usually managed through long-term contracts with TSO (frequency control support) or DSO (voltage control support and congestion management), which may include real-time service requirements (voltage & reactive power support; congestion management through load curtailment).

The paper will present the optimization problems used in the 3DMicroGrid project to determine the set-points of the different resources present in the microgrid to provide ancillary services to the power system in grid-connected operation: frequency control, voltage control and load curtailment.

Results of the optimization of the pilot microgrids used in 3DMicroGrid will be presented.