H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project: Ancillary services in aCTIVe distribution networks bAsed on moniToring and control tEchniques

Principal Investigator: Theofilos Papadopoulos

Reader-friendly title: ACTIVATE

Scientific Area: Engineering sciences

Institution and Country: Democritus University of Thrace (DUTH), Greece

Host Institution: Democritus University of Thrace (DUTH)

Collaborating Institution(s): Aristotle University of Thessaloniki, Norwegian University of Science and Technology, University of Strathclyde

Project webpage (if applicable): https://activate.ee.duth.gr/

Budget: 190000

Duration: 36 months

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Research Project Synopsis

Nowadays, electrical networks are facing a transition towards the proliferation of distributed generation, which is mainly caused by the advent of distributed renewable energy sources (DRESs), and is promoted by national and international policies. This, however, poses unprecedented technical challenges for the smooth and reliable network operation, such as voltage regulation issues, overloading of network equipment, abnormal frequency deviations, and dynamic stability problems. The main objective of ACTIVATE is to develop novel and ready-to-apply ancillary service solutions for transmission and distribution system operators. The solutions aim at addressing the emerging grid operation challenges caused by the increased DRES penetration and especially their intermittent nature.

Technically, ACTIVATE will propose the design of hybrid control strategies, combining features of centralized and decentralized concepts to improve the performance of the network operation. In order to extend the applicability of the proposed hybrid strategy also a virtual inertia scheme will be incorporated to modify the control strategies of DRES converters. To enhance further the adaptability of the provided virtual inertia and to modify the overall dynamic response of the power system, energy storage systems will be used with novel congestion management techniques. Additionally, an innovative network monitoring architecture will be proposed to determine the converter virtual-inertia parameters and coordinate the hybrid control strategy operation. Finally, to facilitate the implementation and application of the proposed scheme in existing distribution grids, a prototype three-phase converter will be developed. This converter will also act as monitoring units providing visibility to DSOs in distribution networks in order to perform stability studies. The ACTIVATE solutions will also be validated by simulations as well as lab tests. ACTIVATE will contribute to the increase of supply reliability and DRES penetration, in an attempt to meet the targets European Union has set to improve sustainability, flexibility, and efficiency in electricity sector.

Project originality

The main objective of ACTIVATE project is to develop novel DSO-oriented and TSO-oriented ancillary service solutions. These solutions aim to address the emerging grid operation challenges caused by the increased DG penetration and especially by the intermittent nature of DRESs. The ancillary services to be developed will be based on exploiting the functionalities the network assets offer including: (a) ESSs, (b) novel operational features of the grid-interfaced converters of ESSs and DRES units, which will be developed within this project, and (c) a new monitoring system architecture for active distribution networks (ADNs) based on measurements acquired locally at the point of common coupling (PCC) of the DRES units. This project will contribute to the increase of supply reliability and RES penetration, in an attempt to meet the targets that European Union has set to improve sustainability, flexibility, and efficiency in the electricity sector.

Expected results & Research Project Impact

- Promotion of innovation in a research topic of major significance at an international level.
- Scientific breakthrough by: (a) proposing novel hybrid control strategies aiming to address the operational challenges caused by the increased penetration of DRESs, as well as to guarantee the safe and reliable operation of ADNs and to ensure the optimal exploitation of network assets; (b) implementing new distributed real-time monitoring techniques, designed to enhance the observability of extended distribution grids; (c) developing a prototype three-phase converter, integrating the proposed control strategies and monitoring techniques; the converter will constitute a readily available product which can be offered to interested parties under license agreements, such as DSOs and prosumers, to enhance their daily operations.
- Support towards achieving RES penetration and emissions reduction binding targets within the context of EU's energy and environmental policy.
- Establishment of evident benefit for the various stakeholders, e.g., DSOs/TSOs, investors in DRESs and regulatory authorities.
- Enhancement of the extroversion of the Greek academic community. Dissemination of knowledge and expertise.

The importance of this funding

ACTIVATE will support the establishment of a "research excellence unit" on energy issues and especially in ancillary services, power systems monitoring and distributed renewable energy sources operation in the Democritus University of Thrace (DUTH). This unit will provide expertise and high-quality consulting services in public institutions and private energy companies and will also help to attract young scientists to energy engineering.

Moreover, the external collaborations with the Aristotle University of Thessaloniki, the University of Strathclyde, and the National Technical University of Norway, will aid to enhance the extroversion of DUTH and extend the ACTIVATE impacts to international frames. Finally, with this funding significant scientific and financial aid will be provided to all participants, i.e., academics, post-docs, PhD and master students.

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