ACTIVATE

Ancillary services in active distribution networks, based on monitoring and control techniques

Issue No 2 December 2020

Dear Reader,

It is our pleasure to welcome you to the second edition of the ***ACTIVATE*** **Newsletter!**
"ACTIVATE—Ancillary services in active distribution networks, based on monitoring and control techniques" is an ambitious research project funded by the Hellenic Foundation for Research & Innovation, and is being implemented by a consortium of 4 highly capable and well established Universities.

If you would like to keep up with all the latest developments of our project follow us on Facebook, LinkedIn & Researchgate.

Kind Regards,
The ACTIVATE Research Team

About ACTIVATE

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 distributed renewable energy sources (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.

H.F.R.I. Hellenic Foundation for Research & Innovation
http://www.elidek.gr

This project has received funding from the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and Researchers and the procurement of high-cost research equipment grant (Project Number: HFRI-FM17-229).

DEMOCRITUS UNIVERSITY OF THRACE

Current Project Progress

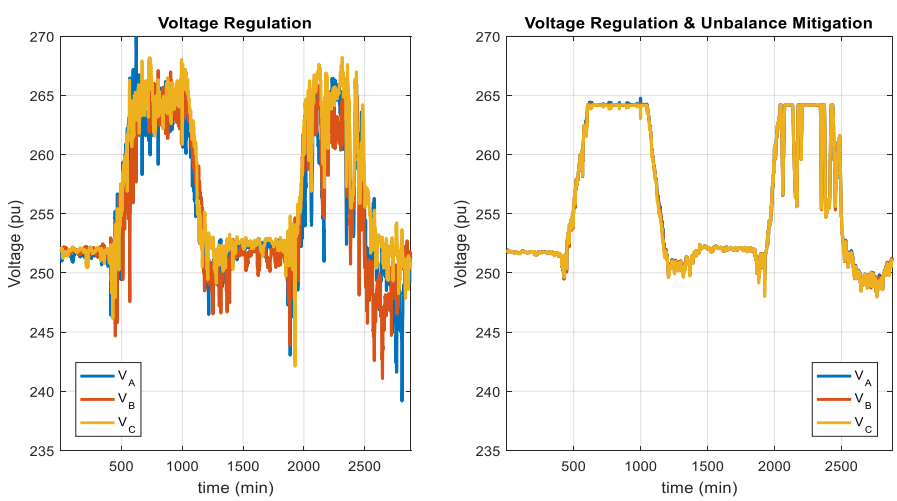
Ancillary services solutions for DSOs and TSOs

In the context of ACTIVATE, **enhanced decentralized control strategies** have been developed, tackling on a local level technical issues related to the penetration of DRESs into the existing distribution grids, such as **overvoltages, voltage unbalances,** and **overloading of network equipment**. In particular:

a) A local controller has been designed to determine the response of battery energy storage (BES) systems and DRES to electrical system changes, by using only parameters available at the point of connection of each unit with the grid. The controller exploits the reactive power capability of DRESs and the storage capacity of the ESSs to **tackle under-** and **overvoltages** in distribution networks.

b) A **voltage unbalance mitigation** control scheme for the inverters of DRES and BES units has been developed. The proposed method introduces a virtual conductance for the negative and zero sequence that affects the level of voltage unbalance mitigation capability of each inverter.

c) A **congestion management scheme** has been designed to tackle the overloading of network equipment. The developed scheme uses the available active and reactive power of BES systems to maintain the line and transformer currents within permissible limits. It is worth mentioning that priority is given to the reactive power to reduce the stress on the BES.



Main lessons learnt

1. The performance of the **local controller** has been evaluated by means of quasi-static simulations. Comparisons with the well-established decentralized solutions, $Q(V)$, $\cos\varphi(P)$, revealed its superiority in terms of voltage regulation and losses.

2. The developed **voltage unbalance control** can efficiently mitigate voltage unbalance, acting in cooperation with the local controller voltage regulation strategy without affecting its performance.

H.F.R.I. Hellenic Foundation for Research & Innovation
http://www.elidek.gr
The project is funded by the Hellenic Foundation for Research & Innovation

Real-time network monitoring and operating techniques

A main task of the project is to examine online monitoring techniques for the analysis of Active Distribution Networks (ADNs). Towards this objective, a measurement-based multi-channel identification method has been developed constituting the core of a three-level monitoring architecture that will be designed within ACTIVATE. In detail:

a) Several real-time **measurement-based identification techniques** for the estimation of the network **modal parameters** at the LV/MV/HV levels have been examined. Among them, the Prony, Matrix Pencil (MP), Vector Fitting (VF), Hybrid FD/TD, etc..

b) Different **signal pre-processing methods** have been tested to facilitate the application of system identification models to real-field conditions. The analysis included the investigation of different types of filtering techniques, types of noise, event-detection techniques, and time alignment and signal synchronization methods

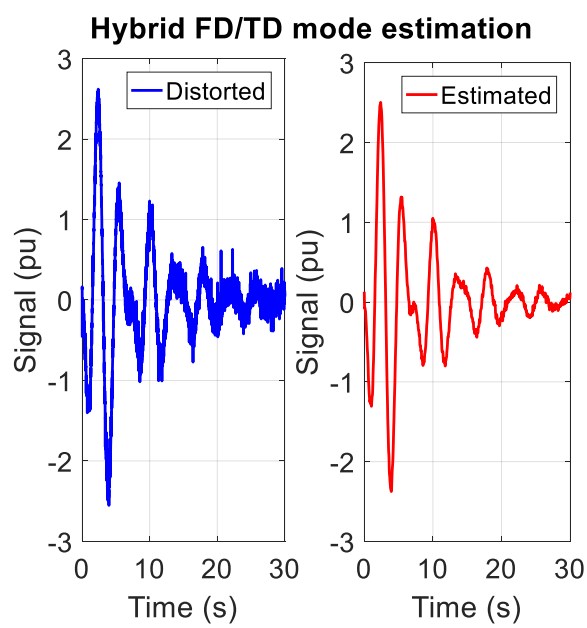
c) A **multi-channel** measurement-based identification method based on the Hybrid FD/TD technique has been developed. Several measurements, acquired from different network buses are processed together to derive network modal estimates and to develop reduced order equivalent models, describing the dynamic behavior of the power system.

Main lessons learnt

1. Initial results revealed that the **Hybrid FD/TD**, **VF** and **MP** methods provide the most accurate mode estimates when stable or sustained oscillations are examined. They are also very robust considering noisy conditions, the type and the level of the examined response.

2. The Hybrid FD/TD can be efficiently used for cases where in the recorded signal missing data or outliers exist. The method also filters out automatically noise very efficiently.

3. **Multi-channel** techniques present higher accuracy compared to single-channel analysis, reducing significantly the impact of noise, canceling also out erroneous mode estimates that may occur.



The project is funded by the Hellenic Foundation for Research & Innovation
H.F.R.I. Hellenic Foundation for Research & Innovation
http://www.elidek.gr

Communication & Dissemination activities

55th International Universities Power Engineering Conference, UPEC 2020

Initial results obtained from the ACTIVATE project were presented in the paper entitled '*Viability Assessment of PV Systems in University Campuses Under the Net-Metering Policy*' presented in UPEC 2020 on 1-4 September 2020. In this paper, the techno-economic assessment of the net-metering policy in medium-voltage (MV) prosumers is discussed. Results from various scenarios are analysed and remarks are drawn regarding the cost-efficiency of net-metering policy of MV prosumers in Greece. In the future steps, the effect of the ACTIVATE voltage regulation techniques on the cost-efficiency of MV prosumers under the net-metering scheme will be investigated.

12th Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion, MEDPOWER 2020

In MEDPOWER 2020 our paper entitled '*Impact Assessment framework of PV-BES Systems to Active Distribution Networks*' was presented, proposing a framework for the assessment of the impact of PV and BES systems on voltage profiles and power losses of active distribution networks as well as of the utilization of battery BES. The proposed framework will be used to evaluate the developed project decentralized voltage regulation techniques, as well as the proposed holistic approach within ACTIVATE. Our paper received the best paper award taking into account both the content of the paper and the quality of the presentation!

H.F.R.I. Hellenic Foundation for Research & Innovation
http://www.elidek.gr
The project is funded by the Hellenic Foundation for Research & Innovation

Project Consortium

Democritus University of Thrace (DUTH)

Power Systems and Electrical Machines laboratories are involved in ACTIVATE. DUTH is proud to be one of the largest Universities in Greece. In this context, it has attracted a significant number of research programs funded by the EU as well as national and private resources. The research team of ACTIVATE consists from two DUTH academics, three PhD candidates and two MSc students..

Theofilos A. Papadopoulos thpapad@ee.duth.gr

POWER SYSTEMS LABORATORY
ARISTOTLE UNIVERSITY OF
THESSALONIKI

Aristotle University of Thessaloniki (AUTH)

The Power Systems Laboratory (PSL) of AUTH is running since 1980 and has been involved in 140+ European, bi-lateral and national projects (http://power.ee.auth.gr/). The PSL and the team members involved in this project have significant experience in all topics related to power systems analysis, operation and control, modelling, distributed generation and smart grids and renewable energy sources.

Grigoris Papagiannis grigoris@eng.auth.gr

University of Strathclyde (UoS)

The D-NAP laboratory of the Institute for Energy and Environment provides an environment for research, development and testing of smart grid functions incorporating PHIL functionalities with real-time simulators. Also, experts in the topics related to power systems modeling and near real-time dynamic security assessment from UoS, will participate in the development of ACTIVATE network monitoring techniques.

Graeme Burt graeme.burt@strath.ac.uk

Norwegian University of Science and Technology (NTNU)

Experts from Department of Electric Power Engineering of NTNU will contribute on the development and testing of the three-phase converter. NTNU experts are specialized in the area of wide band gap power converters design, gate and base driver designs for WBG devices, as well as dc-breaker concepts for MV and HVDC systems.

Dimosthenis Peftitsis dimosthenis.peftitsis@ntnu.no

The project is funded by the Hellenic Foundation for Research & Innovation
H.F.R.I. Hellenic Foundation for Research & Innovation
http://www.elidek.gr