ACTIVATE

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

Issue No 6 December 2022

Dear Reader,

One step before the end of ***ACTIVATE*** *"Ancillary services in active distribution networks, based on monitoring and control techniques"* it is our pleasure to welcome you to the sixth edition of the ***project*** **Newsletter!**
ACTIVATE 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

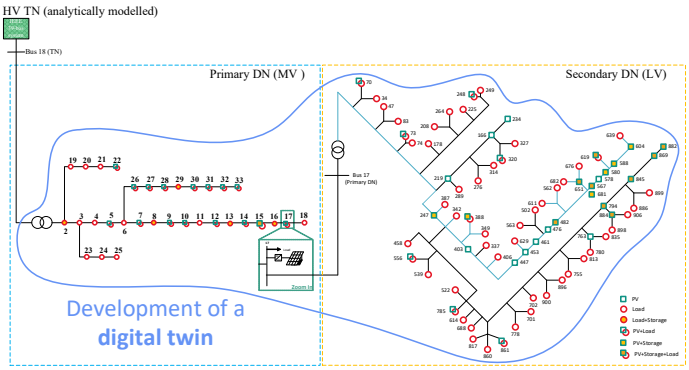
Project Progress So Far

Validation of the proposed control and monitoring architecture with simulation and experimental results

The **control strategies**, the **monitoring architecture** and the **prototype converter** developed in ACTIVATE are validated by means of **simulation and laboratory tests**.

Towards this objective, the performance of the designed ACTIVATE **ancillary services (ASs)**, are tested by means of simulations in a combined transmission, primary and secondary distribution network, designed specifically for the needs of ACTIVATE. Some of the provided ASs include **(1) power smoothing**, **(2) voltage regulation**, **(3) voltage unbalance mitigation** and **(4) congestion management**.

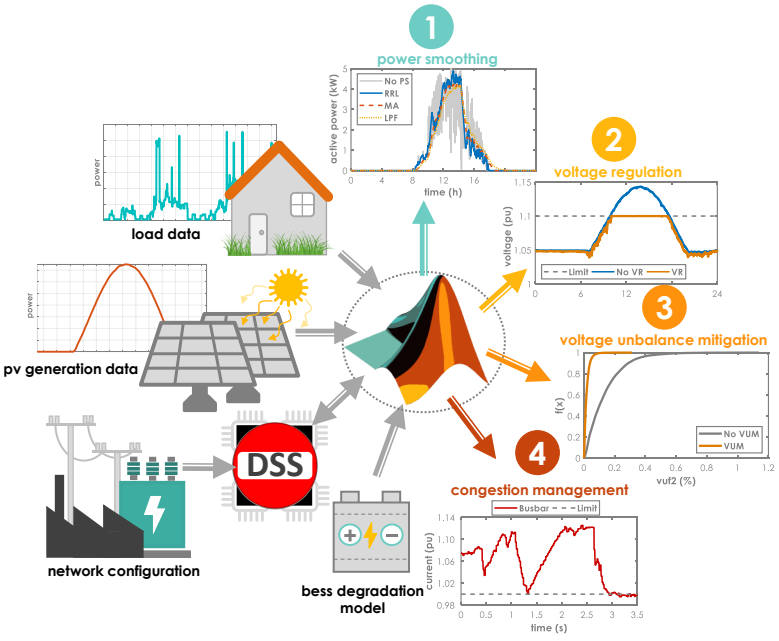
Using the combined transmission, primary and secondary distribution network model, dynamic simulations were also conducted to test the features of the proposed three-level distribution architecture. At this step, our work focuses on the development of **digitally twin distribution network equivalent** models in experimental results.



Lessons learnt

Investigations are ongoing. From the analysis conducted up to now it was shown that:

1. the proposed power smoothing, voltage regulation, voltage unbalance mitigation and congestion management ASs can be applied to both primary and secondary distribution networks and solve the corresponding problems,
2. the designed three-phase four-wire DC/AC converter can be efficiently operate in unbalanced low-voltage distribution networks. Its performance has been evaluated both in terms of software simulations and also of hardware-in-the-loop (HIL) simulations in the partner University of Strathclyde,
3. by selecting an appropriate equivalent model, a digital twin for the analytically modelled primary and secondary distribution networks, which accurately replicates their dynamic behavior, can be developed.



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57th International Universities Power Engineering Conference, UPEC 2022

Our paper "**Combined Transmission and Distribution Test System for Small-Signal Stability Analysis: Initial Results**" was presented in UPEC 2022 on 30 August—2 September 2022. In this paper, a combined transmission and distribution network synthetic model is developed to investigate the dynamic performance of an overall power system and analyse the interactions between its constituent parts. Conventional and modern power system configurations are considered. The small-signal stability of the power system is investigated by means of eigenvalue analysis and by applying the matrix pencil algorithm to identify the dominant modes contained in the dynamic responses.

URL: *https://doi.org/10.1109/UPEC55022.2022.9917807*

5th International Conference on Smart Energy Systems and Technologies (SEST)

Our paper "**Assessing the Provision of Ancillary Services Considering BES Capacity Degradation**" was presented in the 5th International Conference on Smart Energy Systems and Technologies (SEST) that took place in September 2022 in Eindhoven, the Netherlands. In this paper, a methodology for the assessment of the provision of voltage regulation and power smoothing services by PV-BES systems is presented, by taking into account the capacity degradation of BES. The proposed framework involves quasi-static simulations incorporating the operating conditions of the distribution network. A battery aging model is used to estimate the BES capacity loss caused by both the calendar and the cyclic aging mechanisms. **Our paper was one out of the total three papers that received the best paper award!**

URL: *https://doi.org/10.1109/SEST53650.2022.9898493*

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Communication & Dissemination activities

2nd International Conference on Energy Transition in the Mediterranean Area (SYNERGYMED)

Two of our papers were presented in the 2nd International Conference on Energy Transition in the Mediterranean Area (SYNERGYMED) that took place in October 2022 in Thessaloniki, Greece.

The first paper is entitled "**Identification of Closed-spaced and Poorly-damped Oscillatory Modes in Ringdown Responses of Power Systems**" investigating the performance of Prony, eigenvalue realization, matrix pencil and vector fitting methods in the identification of closely spaced in frequency and poorly damped modes by using synthetic signals.

URL: *https://doi.org/10.1109/SyNERGYMED55767.2022.9941458*

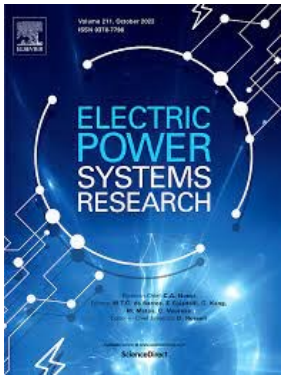
In the second paper entitled "**Wavelet-based Automatic Processing of Dynamic Responses for the Development of Dynamic Load Models**" an efficient method for event detection and noise reduction of dynamic responses based on Wavelet Transform is proposed, aiming to improve this way the quality of data used for the derivation of load models.

URL: *https://doi.org/10.1109/SyNERGYMED55767.2022.9941470*

Journal publication

The project paper entitled "**A unified control strategy for voltage regulation and congestion management in active distribution networks**" was published in Elsevier's Electric Power Systems Research Journal. The paper is the result of the research effort within WP2 and describes the ACTIVATE unified control strategy for unbalanced low voltage distribution grids to providing ancillary services of voltage regulation, voltage unbalance mitigation and congestion management control.

URL: *https://doi.org/10.1016/j.epsr.2022.108648*



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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..

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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.

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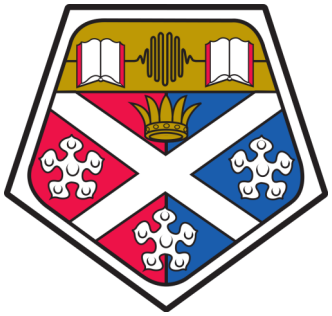

University of Strathclyde (UoS)

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.

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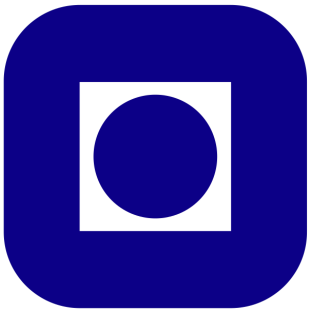

Norwegian University of Science and Technology (NTNU)

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.

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