European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out

TRANSNATIONAL ACCESS
USER PROJECT FACT SHEET

USER PROJECT	
Acronym	DERT4PM
Title	DISTRIBUTED ENERGY RESOURCES AS TOOLS FOR POWER MANAGEMENT
ERIGrid Reference	02.002-2017
TA Call No.	2

HOST RESEARCH INFRASTRUCTURE			
Name	ICCS-NTUA		
Country	Greece		
Start date	05/03/2018 , 17/06/2018	Nº of Access days	19
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USER GROUP	
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1. USER PROJECT SUMMARY (objectives, set-up, methodology, approach, motivation)

This research addresses the voltage and frequency problems encountered in a Low Voltage microgrid via the application of the droop control concept to inverters to provide ancillary services. This was tested in grid-tied mode and also in an islanded grid with various forms of DER, loads and storage to create realistic residential microgrid scenarios.

The experiments were conducted using a Power hardware in the loop (PHIL) setup, where hardware PV inverters and hardware battery energy storage system (BESS) were used in parallel with circuits simulated in the Real-Time Digital Simulator (RTDS). The experimental results justify the essence of using inverters as reactive power management tools in the LV grid.

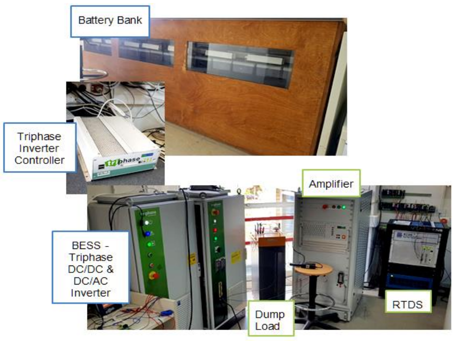

Fig 1: Low Voltage PHIL test facility at NTUA, Greece

2. MAIN ACHIEVEMENTS (results, conclusions, lessons learned)

The results show the ancillary service supply opportunities from the inclusion of DGs in the LV grid, despite being regarded as intermittent sources by grid operators. Using the PHIL test set up, ancillary services were supplied to the grid in combination with the conventional OLTC, which was supported by the physical inverter's Q(U) droop control, leading to a reduced number of tap changes of the OLTC. The extension of the droop concept in a distributed LV microgrid was also applied to multiple PV inverters. In other scenarios, the distributed PV inverters were also able to supply excess power via the PCC to the main grid.

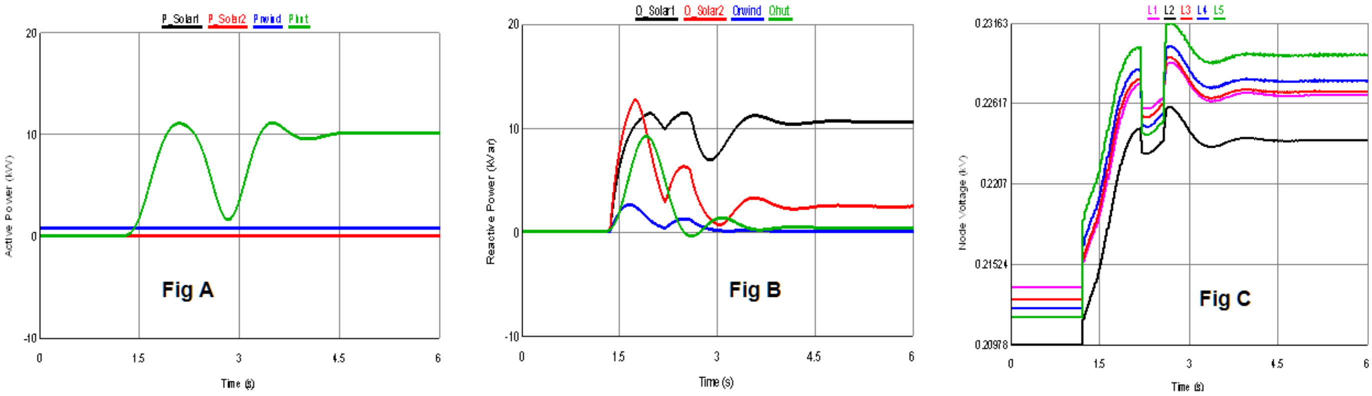

Fig A: Hardware battery in PHIL dispatching active power to the islanded grid whilst there's no solar insolation.
Fig B: Reactive power compensation by the PV inverters through droop control.
Fig C: Node voltage improvement due to reactive power by the PV inverters.

In the islanded experiment, it can be seen that the energy storage played a key role in storing excess power from the PV or Wind inverters, while it dispatches power when the wind or PV inverters cannot supply enough active power (Fig A). Even in test scenarios where the PV panels receive no solar insolation, the PV inverters are generating reactive power (Fig B), as a result of a change in the load, and this improves the voltage profile of the grid (Fig C).

3. PLANNED DISSEMINATION OF RESULTS (journals, conferences, others)

We are planning to prepare and submit three papers for publication. The first will be an introductory paper to present the dynamics of the droop control of the inverter and how it supports the existing OLTC in provision of LV ancillary services. The next paper will present a decentralized control methodology to inverters which will not only serve the local loads but also feed aggregated power into the main grid. The final paper will examine the provision of ancillary services in an islanded LV grid, where the battery energy storage system will play a vital role in the power balance, in a decentralized control system. The CIGRE LV grid benchmark is used in our research work. The publishers for these papers will be most likely IEEE / IET.