

# Network of Excellence DERlab activities for transition towards more Decentralised Energy Systems

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**Abstract** – The activities of Network of Excellence DERLab oriented to sustainable integration of distributed energy resources into public distribution electrical grid and the transition towards Decentralised Energy Systems are described in the present paper. The new conditions of decentralised generation determine the necessity to perform tests, to compile the new data base and new experience, to have pre-competitive and pre-normative research. Education and training activities towards new decentralised energy systems requirements are the focus of the universities partners.

**Keywords** – Distributed Energy Resources, Decentralised Energy Systems

## I. INTRODUCTION

Sustainable Development requires the use of cleaner energy resources. The connection of new decentralised and clean energy resources to the grid can help in reducing the environmental impact of power production. Furthermore, the introduction of new technologies can improve the performance of the electrical network, increase the reliability and the quality of the supply and offer a more flexible and efficient service.

As more and more decentralised energy resources are integrated in the distribution network, it will be necessary to use laboratory tests to validate the new concepts for analysis, planning, control and supervision of the electricity supply and distribution in order to take these new components into account in the performance optimisation of the whole system.

## II. DESCRIPTION OF THE MAIN ACTIVITIES

The main goal of the network of excellence DERLab is to support the sustainable integration of renewable energy sources (RES) and distributed generation (DG) in the

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electricity supply by describing common requirements, development quality criteria and supporting international pre-standardisation activities.

Network of Excellence DERLab supported by European Commission, is composed of eleven research institutions from eleven European countries.



Fig. 1 The DERlab network ([www.der-lab.net](http://www.der-lab.net))

- ISET (D) (co-ordinator): Test and Certification Centre for Modular System Technology
- UKDG Manchester (UK): The UK Centre for Distributed Generation and Sustainable Electrical Energy
- KEMA(NL): T&D Testing Services/High Voltage Laboratories
- LABEIN (E): Distributed Generation Laboratory
- Riso DTU (DK): Test and certification centre for wind turbines and facility for hybrid and system simulation and testing
- Arsenal research (A): Testing laboratory for system components for Photovoltaic and other DG applications
- NTUA-ICCS/(GR): Test facility for hybrid systems and mini-grids
- CESI (I): Distributed Power Generation Test Facility
- CEA/GENEC/LSEC (F): Laboratory for storage technologies
- TU Sofia (BG): Power electronics laboratory
- TU Lodz (PL): Power quality laboratory

### Sustainable Networking

In September 2008 the DERlab network partners have founded the association "European Distributed Energy Resources Laboratories – DERlab" as an independent world-class laboratory for the grid-integration of distributed power generation.

## Staff Exchange

DERlab is committed to providing developmental opportunities to equip staff with the knowledge, skills and motivation required to play a part in achieving Europe's vision of sustainable energy supply.

Objectives of such a professional network

- Establish professional development of staff involved
- Boost knowledge/services transfer through dissemination of good practices and tools
- Represent the members at European level, influence knowledge transfer & innovation policies

## Survey of Laboratories and Test Infrastructure

A survey of European test facilities for DER is provided on the DERlab web site with the objective to support the mutual use of existing infrastructure. The equipment and testing services available at the partner laboratories are compiled in the data base DERlab esd (DERlab equipment & service data base). The data base facilitates the integration of the DERlab network by providing a survey of the test facilities and equipment of each partner. This way the experience of single laboratories with specific equipment can be made available for the entire network and it provides the platform for the shared use of equipment and test capabilities. Building up the Network of Excellence – Fig. 3



Fig. 3 Network of DER Laboratories

## Joint Research

### Interconnection Requirements

The absence of a harmonised interconnection standard has been identified as one of the most severe obstacles towards the wide deployment of DER and as a result to the change towards active electricity networks. After analyzing national DER interconnection requirements DWERlab proposed a common structure for a European standard as input to Cenelec TC8X WG03. Furthermore a public available data base is provided to foster the research and standardisation activities in this area.

### International White Book on Grid Integration of Static Converters

Grid inverters are the key elements to massively integrate distributed renewable energy sources into the power system. In this context DERlab has initiated the preparation of an international white book to identify research and standardisation needs and to define common European requirements for the grid inverter in the future. The book covers the topics of DER ancillary services, behavior under fault conditions, communication and control. The developed draft concept is available on the DERlab Internet Portal.

### Electromagnetic Compatibility (EMC) of DER Systems

EMC has been detected as one of the main technical and regulatory barriers for DER integration. DERlab created an internal "Working Group on EMC for DER" to cope with the critical issue of EMC related to DER. Different tasks are still in progress but first results have been collected in a draft Guide Document available on the internet. The DERlab Guide Document explains the different characteristics, requirements and certification procedures applied to both categories (apparatus and fixed installations) according to the EMC Directive. The DERlab inputs concerning the EMC are welcomed by the IEC 61000-3-15 project team; consequently DERlab influences on an international level the progress of EMC for DER.

### Development and Enhancement of DER Testing Procedures

The penetration rate of DER units in distribution grids and the rated power of the single units will increase massively. This will lead to tighter interconnection requirements and to the necessity of independent testing laboratories with harmonised testing procedures on a high quality level to achieve comparability and confidence. Test procedures for photovoltaic inverters – Fig. 4

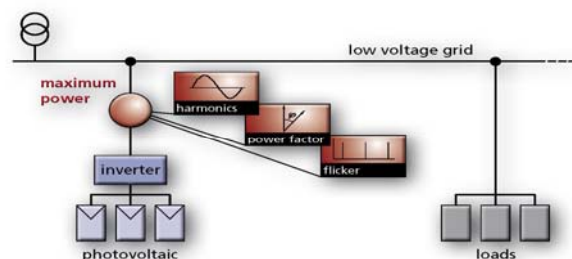


Fig. 4 Test bench for photovoltaic

DERlab partners already contribute to this direction by performing common tests on PV inverters in their laboratories.

### National Information Exchange and Networks

On the national level all DERlab members are establishing and maintaining national networks for an intense information exchange with the national DER-communities and to receive feedback at an early stage. All DERlab members act as contact points to coordinate the activities in their European region. Please refer to your contact point for further information about the networks – Fig. 5

Austria, Hungary Czech Republic Slovakia	<b>Arsenal research</b> Roland Bruendlinger <a href="#">Contact</a>
Denmark Finland, Sweden	<b>Risoe DTU</b> Per Norgard <a href="#">Contact</a>
Germany	<b>ISET</b> Thomas Degner <a href="#">Contact</a>
Italy, Sloveia Malta	<b>CESI RICERCA S.p.A.</b> Paolo Mora <a href="#">Contact</a>
Poland, Estonia Lithuavia, Latvia	<b>Technical University of Lodz</b> Piotr Gburczyk <a href="#">Contact</a>
United Kingdom Ireland	<b>The University of Manchester</b> Joseph Mutale <a href="#">Contact</a>
Bulgaria Romania	<b>Technical University of Sofia</b> Anastassia Krusteva <a href="#">Contact</a>
France	<b>CEA INES</b> Jens Merten <a href="#">Contact</a>
Greece, Cyprus	<b>National University of Athens – ICCS</b> , Nikos Hatziargyriou <a href="#">Contact</a>
The Netherlands Belgium, Luxembourg	<b>KEMA</b> Peter Vaessen <a href="#">Contact</a>
Spain Portugal	<b>LABEIN-Tecnalia</b> Eduardo Zabala <a href="#">Contact</a>

Fig. 5 DER network contact point

### Workshops

A main reason for the establishing of DERlab is the support of European manufacturers, grid operators and other stakeholders by establishing a discussion platform, identifying relevant problems and proposing solutions. The first workshop series lead to the wrizting of the International White Book on Grid Integration of Static Converters. The second is currently dealing with DER interconnection requirements and is strongly related to Canceled activities. A third workshop series on grid-tied storage is under preparation.

### III. TRAINING AND EDUCATION – FOCUS OF THE UNIVERSITIES PARTNERS

Available educational and training programs were investigated to determine existing and missing topics for DER education in the countries. Listing of the available 52 educational and training programs: The University of Manchester – 12,

TU Lodz – 10, TU Sofia – 15, NTU of Athens – 15 on hand in the following subjects:

- Electric power generation
- Electricity grids
- Power Electronics
- Voltage Regulation
- Power Factor Correction
- Renewable Energy Resources
- Heat Production and Transmission
- Combined Heat-Power generation
- Information and Control Systems

The target of the analyses of the conventional programs was to obtain the interconnection with the parameters and standards on the Distributed Power Generation and to develop a set of training educational programs, oriented to fully integrated Active Network, based on Distributed Energy Resources and modern information technologies.

The general conclusion is that education and training university courses are oriented towards some aspects of DER, but a global unique point of view for Active Networks is missing. There are no programs attended to advanced power electronic devices and circuits for DER, control information technology for DER, testing and standardisation problems. It is now necessary to introduce among the regular university courses a program able to propose the new vision of energy production and management in the context of the future Electricity Smart Grid.

- DERlab partners are going to organize common PhD seminars in the area of DER integration into power systems in October 2009 in Athens;
- DER training courses for the industry – “Electric Energy Systems - University Enterprises Training Partnership” (EES-UETP) are investigated. In future collaborative partnership in these courses is intended.
- The TU Lodz has recently started the new post-graduate training course for industry, which concerns modern effective installations in buildings including renewable energy sources.

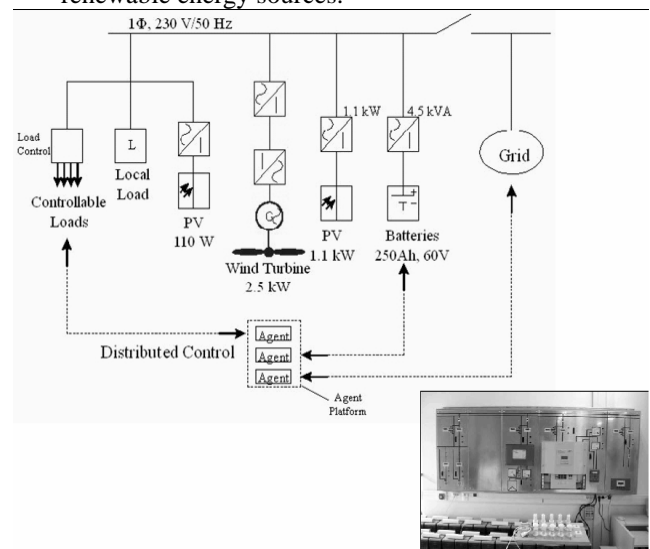


Fig. 6 – Microgrid connected to the local LV grid - National Technical University of Athens – “Institute of Communication and Computer Systems”

The need for common research and related interdisciplinary educational and training courses will be the right way for future expertise in the field of the distributed energy system. For examples of complexity of DER problems the Fig. 6 and Fig. 7 are presented.

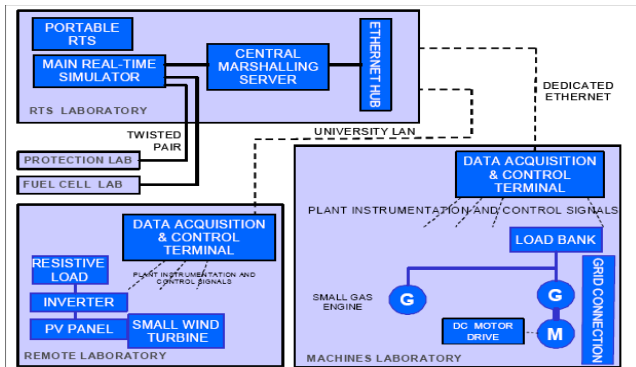


Fig. 7 Test - bench DER system - University of Manchester “Centre for Distributed Generation and Sustainable Electrical Energy”

New subjects, additional to the existing programs are currently introduced in TU Sofia, NTUA, University of Manchester and TU Lodz:

- Advanced power electronic devices for DER: Multi-input DC/DC Converters;
- Microgrids;
- Multilevel DC/AC Converters;
- Interface between DC/AC;
- Converters and supply network;
- Control information technology for DER - current codes and regulations, power-line and wireless communication for data acquisition and control purposes for DER;
- Protocols and information exchange;
- Modelling & Simulation of Power Network with DER;
- Control & Protection of Networks with DER;
- Power Quality in Networks with DER; Active filters;
- Standards for DER, connected to plant, devices models and interoperability tests;
- Power Quality in Networks with DER; Active filters;
- Design and Exploitation of Networks with DER;
- Load balance and storage for mini- and microgrids;
- Smart Grids.

DERLab universities partners will elaborate the proposals in the area of DER integration for modifications of educational and training programs for students, post graduated PhD students and professionals.

DERlab partners are going to organize lectures in order to promote and disseminate good practices across Europe

## IV. CONCLUSION

This report presents in brief the activities and opportunities of DERlab and expected achievements:

- To develop a pan-European laboratory, recognised as a leading laboratory in the field of future decentralised network;
- To support the development of European and international standards by executing new research activities;
- To support durable networking for long-lasting creation of European competence in the area of “New DER technologies and their Integration into the Future Distribution Network”
- The provision of education and training opportunities in the area of DER integration.

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