REPORT

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DERri

Distributed Energy Resources Research Infrastructures

Integrating Activity: Combination of Collaborative Project and Coordination and Support Action

SEVENTH FRAMEWORK PROGRAMME

Capacities Specific Programme

Research Infrastructures

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		C. Mayr	AIT	NA2 Section
		W. Heckmann	IWES	NA3 and JRA1 Sections
		N. Martin	CEA-INES	JRA2.1 Section
		R. Bründlinger	AIT	JRA2.2 Section
		T. Strasser	AIT	JRA3 Section
		S. Numminen	DERlab	Dissemination Section

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NOTES:

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For more information on the project DERri, link to **http://www.der-ri.net**

INDEX

EXECUTIVE SUMMARY

The DERri project aims to strengthen and improve the collaboration of the leading European research infrastructure partners in the field of Distributed Energy Resources (DER) and Smart Energy Networks. It addresses these aims through improving the European DER platform of common research and knowledge. The objective of DERri is to support industrial innovation and solidify the European position in DER research; these objectives are achieved by enabling access to leading laboratories, by cross-fertilisation of ideas and concepts, and by streamlining procedures and quality assurance of existing facilities. Thus, an increased level of organisational and technical alignment of laboratories offers industry a unique access to know-how and allows Europe to take the lead in RES research; that is essential in the global effort to combat climate change.

This report summarizes motivations, objectives, and results achieved during the four years of the project and the collaboration of the 16 leading laboratories from across Europe and united in DERri. The improvement of the experimental capacity of the Research Infrastructures is necessary to adequately support the Smart Grid evolution. This Smart Grid evolution will increase the usage of sustainable energy in Europe, further developing that energy sector and so supporting the economy of Europe. DER has an essential part in the transformation of the energy sector, as can be seen in the dramatic growth of the Renewable Energy Resources penetration into the electricity generation market.

Integration of DER requires innovative technology solutions, as DER greatly impact on the electrical system management and stability, and can affect the quality of supply. Technology solutions need validation and their impact on the system must be properly assessed: Research Infrastructures have to provide solutions to meet these requirements.

To respond to these strategic requirements and pursue its strengthening objective, DERri developed its activities according with the I3 formula proposed by EC: it and includes Joint Research Activities (JRAs), Networking Activities (NAs) and Transnational Access Activities (TAs).

JRAs developed tools and testing methods aimed at integrating, coordinating and managing the potential of the cooperating laboratories. One main achievement is the development, setup, and validation of the JaNDER concept; an interconnection platform enabling the DERri laboratories to act as a unique, virtual Research Infrastructure. This may greatly improve the experimental capacity of the laboratories by leveraging complementary capabilities and similarities. A second result worthy of mention is the development of innovative testing methods and procedures. Whilst enhancing the portfolio of the labs services, the JRAs supplied new, essential, methods to demonstrate the performances of essential components (storage systems and large inverters) and to assess, through laboratory experiments, the real time impact of DERs integration into the Grid otherwise requiring impractical and expensive tests if made in the real power-system.

Networking Activities allowed the DERri laboratories to share methods, procedures and reference standards to enable them to increase their collaboration. They aimed to create the conditions to guarantee the reliability of the activities performed in each facility, and their traceability; to facilitate this Common reference Quality Standards have been agreed. The execution of round robin tests, based on Power-Hardware-in the-Loop use cases, allowed the exchange and comparison of good practices. Also within the Networking Activities, the website (www.der-ri.net) of the project was developed for use not only for the dissemination of DERri results, but also to provide easy access to the labs of external users within the Transnational Access activities.

Finally, TA activities represented an important added-value experience for DERri laboratories, attracting more than 60 research projects proposed by external users. The projects, selected by

an external experts committee, cover all the most crucial technical topics in the Smart Grid evolving research and development space. About 100 users accessed DERri facilities and benefited by more than 750 use days at the research infrastructures.

Results of DERri activities and from the external users projects have been widely published in conferences, workshops and articles also in peer reviewed journals.

1 CONTEXT AND OBJECTIVES

DERri ("Distributed Energy Resources research infrastructure") is a "Research infrastructures" project, dealing with Distributed Energy Resources (DER) and smart electricity grids. It is a EU Integrating Activity - Combination of Collaborative Project and Coordination and Support Action under the FP7 research programme.

The main objective of DERri is the enhancement and the effective deployment of experimental infrastructures in support of the research on the Distributed Energy Resources integration in the EU energy system.

Distributed Energy Resources (DER), are in fact the backbone of the evolving Smart Energy Networks. Indeed, DERs play a fundamental role to make "smart" the energy system. DER concept, by decentralizing the generation so far committed to few high power and monopolistic plants, foster the exploitation of the Renewable Energy Sources (RES), thus reducing the CO2 emissions and the use of fossil fuels. The possibility to manage their own energy resources, including generators, loads and accumulators, empowers the consumers, transforming them into "prosumers", i.e. into active energy users able to interact with the grid either directly or through intermediate aggregators. This latter use case appears very attractive, for the possibility to constitute Virtual Power Plants (VPP) formed by a network of several and of different nature generators. This is not the only way for prosumers to interact with the energy system through the deployment of the DER potential. Flexibility of production and consumption are becoming more and more promising and attractive, much more because of the increased awareness of the consumers about them being active energy actors. Flexibility in fact is operated through mechanisms of Demand Response between the users and the grid operators or other intermediate players. Flexibility is considered among the services-to-the-grid, together with other services in support to the quality and security of the supply. Frequency and voltage stabilization, load shedding and peak shaving are examples of such services which may be agreed between grid operators and distributed generators. Besides the effects on quality and security of supply, DER may bring enormous financial advantages to the grid operators. Indeed, DER allow differing big investments, which would be necessary to fulfil the increasing energy request: a smarter management of the grid configuration, made possible also by the remote control of DER, makes it possible to deploy at the best the capacity of the network. Smart home technology and electric vehicle solutions may be included among the DER for their beneficial impact on the grid smartness and on the energy consumption saving.

In overall, the expected impact from the DER approach is, besides the already mentioned increase of diffusion of Renewables and the lowering of the carbon emissions, the reduction of the consumptions of the users and, in the end, of the costs for consumers and grid operators. All this is in agreement with the EU 20/20/20 directives. There is actually a great ferment in Regulations, Standards and policy actions to incentivize the transformation of the energy system. New business models are evolving generating a proliferation of new stakeholders at the different levels of the energy value chain. Acceptance by consumers is a pre-requisite to raise and to foster.

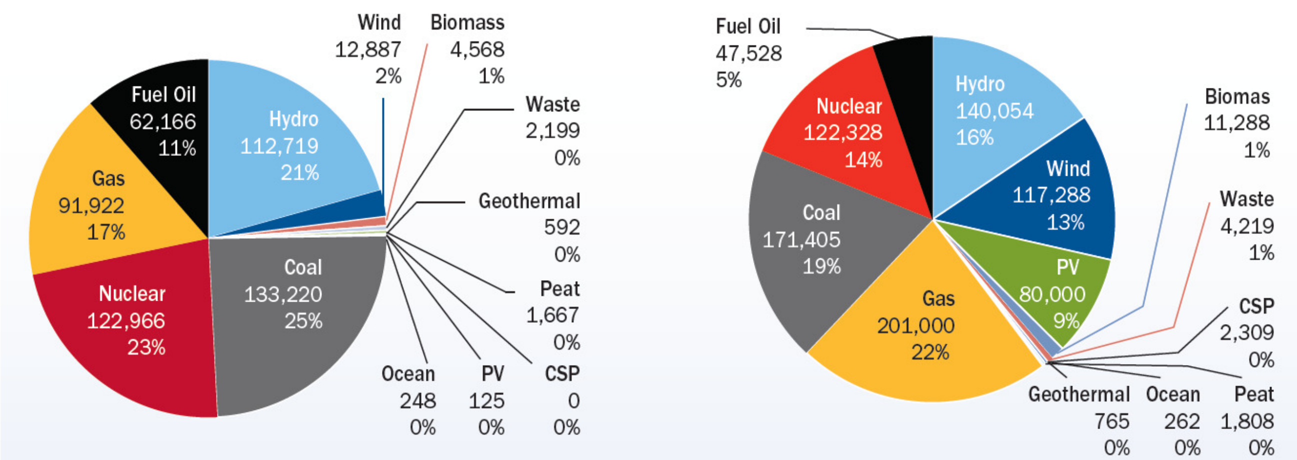
Clearly, such a deep transformation is not priceless and poses important problems of technological and non-technological nature.

Active integration of DER imposes changes in the management approach of the grid by operators to optimize the exploitation of the energy potential while guaranteeing the quality and security of the supply and the safety conditions of personnel, technologies and of the grid itself. Remote control of DER combined with a widespread monitoring of network and devices is a condition for their participation in the flexibility and ancillary services market. To these extents, the electric network and the communication network shall strictly interact, whilst protocols and standards have to ensure interoperability conditions. Compliance conditions of equipment have to be defined to minimize the risks of the DER integration.

Not to say of the grid renovation necessary to make it possible the full integration of widespread energy resources like electric vehicles.

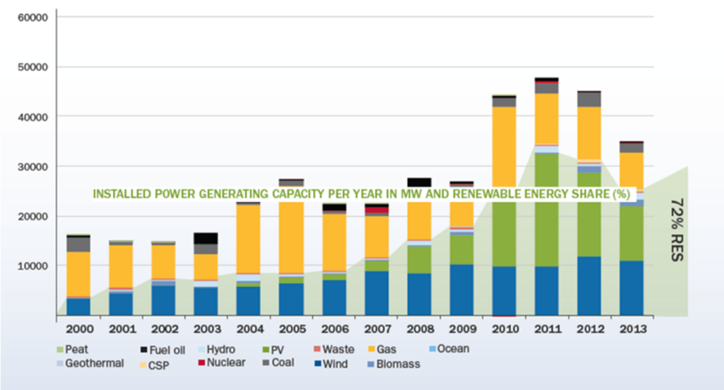
In spite of the great benefits expected from the Smart Grid evolution, the risks associated with the physical integration of DERs already represent a crucial growing problem.

The transformation process is already in progress in the EU, with an explosion in the last 5 years, in spite of the generalized economy crisis: just to mention, the RES capacity in Germany has duplicated since 2008 and, in the only year 2011, as many as 10 GW of PV were installed in Italy.



Change of the EU energy mix (2000-2013) as the effect of DER penetration – Ewea 2014

A massive integration of RES - especially in presence of intermittency, as for PV and Wind generators - poses new and serious problems to the electric system stability and, if not adequately managed, may strongly affect the quality and the security of the supply. It is a fact that it may cause dangerous changes in the electric properties (voltage and frequency) and in the performances of the grids (current flow direction, losses, etc.). These changes can be generated by the connection/disconnection itself of the DER units or modification of their generation level or by operations of optimization (e.g. re-configuration) of the grid both in normal and emergency (e.g. fault) conditions.



Installed power generating capacity per year in MW and rebewable energy share (%) – EWEA 2014

In the overall framework here depicted, the new technology plays an essential role to make the transformation possible. Technology includes, for instance, innovative generation equipment; storage systems; devices for connection to the grid; monitoring instruments; management and control hardware and software tools; communication solutions; protection systems, etc.

Research is necessary to support this strong revolution of the energy system and excellent Research Infrastructures, equipped with experimental testing facilities, already exist in EU to carry out research and to develop and validate technology solutions. They are widespread all over EU and actually belong either to public and private organizations. Their approach to the research reflects the nature and the tradition of the mother organization: trivially, scientific objectives differ from commercial ones. Fields of expertise, procedures, methods, equipment and resources vary from infrastructure to infrastructure. Normally, the infrastructures do not tend to work together in synergy, because of many reasons related to technology but mainly because non-technological (e.g. economical, language, internal regulations, privacy and security, etc.). Research Infrastructures need a large amount of investments, which often make them unique. They constitute a capital of expertise and potential of technology to be constructed, developed, maintained and exploited. However, the described Smart Grid transformation imposes new requirements to the experimental testing by means of the Research Infrastructures, in order to maximize their full deployment and to save money. First of all, experimental facilities should improve their capabilities to fulfil the specifications demands of innovative equipment. This requests new technical features of the facilities and investments. It also implies the definition and validation of adequate testing procedures. The new testing approach must conform to the following main features:

- it must be “systemic”, i.e., besides the experimentation on single devices and equipment it should demonstrate the operation of the overall system (namely, the grid or the part of it) where such devices are integrated. Clearly, the best condition for such a demonstration should be the real environment but this solution is often unpractical and expensive. Some existing Research Infrastructures are especially equipped for laboratory demonstration, although with limitations.
- It must be “multidisciplinary”. As said above, “Smart” evolution implies the strict interaction of different disciplines: electricity generation, transportation and transformation, communication, control, monitoring, etc.. Existing Research Infrastructures are often organizations specialized in a discipline.
- It must be “shared”, i.e. based on agreed methods and procedures acknowledged as widely as possible to ensure the traceability and reproducibility of the tests in different laboratories. This implies matters of quality assurance and impacts on the competitiveness of the technology producers.

Finally, Research Infrastructures have to be “open” to the largest access and dissemination of the results to foster the cross-fertilization of ideas and technologies and to avoid wasting of money by exploiting the existing infrastructures.

The above features represent the target of the DERri actions in order to attain its main objective.

As many as 16 European Institutions from 12 different countries have been cooperating in the project during four years, from Sept 2009 to Dec 2013, constituting in fact a networked Research Infrastructure under the denomination of DERri. They include excellent EU Research Infrastructures with leading DER expertise and equipped with unique testing facilities.

1	Ricerca sul Sistema Energetico	RSE	IT
2	Austrian Institute of Technology	AIT	AT
3	The French National Institute for Solar Energy	CEA-INES	FR
4	Center for Renewable Energy Sources	CRES	EL
5	The EDF group	EDF	FR
6	Fraunhofer IWES	IWES	DE
7	Technical University of Denmark	DTU	DK
8	TECNALIA Research & Innovation	TECNALIA	ES
9	National Technical University of Athens	NTUA-ICCS	EL
10	KEMA Nederland BV	KEMA	NL
11	Technical University of Lodz	TU LODZ	PL
12	Technical University of Sofia	TUS-RDS	EL
13	VTT Technical Research Centre of Finland	VTT	FI
14	University of Strathclyde	USTRAT	UK
15	University of Manchester	UNIMAN	UK
16	European Distributed Energy Resources Laboratories	DERlab e.V.	DE

DERri Consortium

All Most of the partners of DERri are also members of the DERlab e.V. Aassociation (www.der-lab.net), which is an independent legal entity that aimsed at, among all in fostering , from a commercial point of view, the access to the consorted member laboratories also from the commercial point of view. Of course, this common interest is a strong motivation for their collaboration in the project.

FIELD OF EXPERTISE \ LABORATORY	RSE - IT	AIT - AT	CEA/INES - FR	CRES - GR	EDF-SA -FR	IWES - DE	KEMA - NL	TECNALIA - SP	ICCS-NTUA - GR	RISOE-DTU - DK	TUS-RDS - BG	VTT - FI	USTRAT - DE
High Voltage & High Power	■	■			■	■	■	■		■	■		■
Power Quality & EMC		■		■	■	■	■	■	■	■	■	■	■
Hybrid Systems & Micro Grids	■		■	■	■	■	■	■	■	■	■	■	■
Power Electronics & Inverters	■	■	■	■	■	■	■	■	■	■	■	■	■
PV Systems	■	■	■	■	■	■	■	■	■	■	■		■
Wind Systems				■	■	■	■	■	■	■	■	■	■
Storage Systems	■	■	■	■	■	■	■	■	■	■	■	■	■
Comm. Tech. and Smart Metering	■	■		■	■	■	■	■	■	■	■		■
Fuel Cell Systems				■	■	■		■				■	■
Biomass Systems	■				■	■		■					
Electric Vehicles	■	■	■	■	■	■		■		■			■
System Security and Reliability			■		■			■				■	■
Smart Buildings	■	■	■			■		■		■			

Complementary fields of expertise of the DERri partners

Fields of expertise of DERri partners cover the whole scientific range of Distributed Energy Resources and Smart Grids. The organisation of all facilities underin a single infrastructure of a number of facilities working in the same field, brings to several advantages and added values for those in search of the suitable experimental facility:

- access to technical facility information of many laboratories under the same technical field
- single entry point for all potential users with clear and homogeneous procedures facilitating the access;
- possibility to have experimental time allocated in the facility more respondent to the specific research needs;
- possibility to be addressed to an alternative equivalent facility, in order to optimise the booking of laboratory time.

According to the pre-fixed objectives and targets the activities of DERri were organized into macro-activities, conforming the so called I3 scheme proposed by the Commission:

- Joint Research Activities (JRA), consisting in actions to improve the quality and quantity of the services offered by the single infrastructures and all together
- Networking Activities (NA), consisting in actions to improve the sharing and synergy among the infrastructures
- Transnational Access (TA), an initiative aimed at fostering and managing the access of European research teams and industries to the networked laboratories of the consortium.

From the operative point of view these macro-activities have been developed through corresponding Work Packages, whose specific objectives are hereinafter pointed out:

JRA1: Joint Test facility for Smart Energy Networks with Distributed Energy Resources (JaNDER).

This Work Package aimed at the establishment of a virtually unique pan-European demonstration laboratory with testing equipment linked with a communication system and suitable as a test bed for different combinations of technologies, aggregation mixes, etc. Multidisciplinary and synergy among the laboratories are the targets pursued by JRA1.

JRA2: Filling the gaps in testing and characterisation methods for DER power components.

Two components in particular were focused, for their improving importance in the evolution of the Smart Grid: storage systems and large inverters. Main objective was the identification, validation, sharing and proposal for standardization of dedicated testing methods and procedures.

JRA3: Real time simulation environment and parameter identification for power systems.

Combining real experimentation and simulation as a testing laboratory method represents a strategic step forward to the systemic demonstration of the integration of DER and equipment into the grid. Objective of JRA3 was to develop, test and validate this testing method, with the intent of widening the Research Infrastructures portfolio and the access of users.

NA2: Common standards and procedures.

Sharing methods, procedures and reference standards is the pre-requisite of the synergy among the Research Infrastructures. This Networking activity aims at creating the conditions to guarantee the reliability of the activities performed in each facility and their traceability. NA2 also had the objective of defining in an agreed format the portfolio of the services made available by each Research Infrastructure and by the Infrastructures network (i.e. DERri) as a whole.

TA: Transnational Access.

Specific objective of this action was to open the access of each networked Research Infrastructure to the widest community of users, either coming from the research and the industry world, with the intent of disseminate at large the awareness about the availability of the Research Infrastructure and to foster the cross-fertilization from Research Infrastructures to the Users and back.

NA1: Management of transnational User access and Services.

This activity was strictly tied to the previous one and aimed at creating transparent, effective and shared conditions for the access of Users to the Research Infrastructures.

NA3: Set up a user support service and NA4: Information and dissemination.

These Work Packages deal with transversal activities, whose objectives were the dissemination of the DERri results and the fostering of the access opportunity exploitation by means of online facilitating tools.

For each of the listed Work Packages, the following paragraphs provide details of the implementation and main achievements as well as an estimation of the expected impact.

2 RESULTS & FOREGROUND

2.1 TRANSNATIONAL USER ACCESS

Main Author: Giorgio Franchioni (RSE – NA1 Work Package Leader)

Research Infrastructures, by definition, have technical/scientific features of excellence, which make them rare and even unique in the panorama of the research. Infrastructures also request require big investments in initial set-up as well as in day-to-day maintenance and operations. In the framework of the current revolution of the European energy system towards the concept of Smart Grids, Research Infrastructures have an essential role, as they are necessary to support the deep transformation of the entire system and the validation of the technological innovations needed. We have already developed these considerations in the previous section, with specific reference to the experimental demonstration necessary to support the integration of Distributed Energy Resources, which is the main topic of DERri.

Within this context, Research Infrastructures have to fulfil the requirements of the stakeholders of the entire Smart Grid value chain, from research to implementation, industrial realization and market exploitation. Furthermore, multidisciplinary approach is integral for Research Infrastructures operating in the Smart Grid field: infrastructures have to cover aspects ranging from electro-mechanics and electronics, to communication and automation, monitoring, management and control, until security and privacy and even problems of socio-economical nature or related to regulative network and standardization issues. All these aspects, in the case of Smart Grids, are far from bringing definitive solutions but require studies and technology innovations to be validated by Research Infrastructures.

The above reasons lead a group of Research Infrastructures dealing with the DER integration in Smart Grids to create a structured infrastructure network. The final objective is to create, all together, a unique Research Infrastructure, where the complementarities of the laboratories, the sharing of knowledge, methods and procedures and the synergies of the installations operators allow overcoming the multidisciplinary and technological gaps. The intent is clearly to improve the offer to all concerned stakeholders, covering their needs and exploiting as much extensively and effectively as possible the precious and expensive technical and scientific potential.

Access to the experimental installations is, of course, a paramount of the success of the above strategies. Not only because it automatically justifies the existence itself of each and of the networked Research Infrastructures, but also because it may support the economical sustainment of the laboratories. This "commercial" outlet usually lacks in the most of the Research Infrastructures, as for their nature of laboratories often belonging to public research and education organizations. Furthermore, there is an objective lack of awareness by the potential users of the existence and availability of the laboratories. Finally it is not yet clear to the concerned stakeholders of the enormous advantages that may come from the use and frequentation of the Research Infrastructures environment. It is a fact that this environment is the habitat where the cross-fertilization of ideas and initiatives may more effectively grow. This may represent of course a reciprocal benefit also for the same Infrastructures.

The Commission has fully understood the depicted situation when has decided to sponsor the access of research teams to DERri, offering them the opportunity to develop their research and to exploit the wide laboratories potential.

With the above reasons behind, DERri has implemented the Transnational Activities in the consorted laboratories, which have specific potential and facilities for experiments in DER integration and, more generally, in Smart Grids related issues

The involved laboratories shared the following "external" objectives:

- To open their installations to the use by external Research Teams, according with the Commission rules and to support these Research Teams, cooperating with them in the development of their researches and providing them training whenever necessary
- To widely disseminate this opportunity all over Europe, thus fostering the awareness about the availability of Research Infrastructures dedicated to the Smart Grid experimentation
- To contribute structuring the research, building the community, encouraging cross-fertilization of ideas
- To contribute developing new technologies and methods through the Users access

However Transnational Access pursue some “internal” objectives equally relevant for the involved laboratories:

- To setting up a shared way to manage the access (as a unique portfolio) applicable beyond the DERri experience
- To enhance the operability and know-how of each laboratory. To strengthen the cooperation of the laboratories, improving and highlighting the respective expertise and complementarities
- To improve the portfolio of each laboratory
- To improve the quality and the efficiency of the offered service

A Work Package of DERri (NA1: “Management of Transnational User Access) was dedicated to the organization and management of the Transnational Access (TA) initiative.

A number of procedures were shared among the participating laboratories, respectively concerning: the overall TA management (Deliverable D-NA-1.1); the contract issues with the users (Deliverable D-NA-1.2); the rules regulating the stay of the users at the facilities (Deliverable D-NA-1.3a);; and the Technical Reporting (Deliverables D-NA-1.3b and D_NA1.4).

DERri launched as many as ten calls in overall, with an average cadence of about 5 months. The first Call was open in December 2009 just after 4 months from the start of the Project.

This important opportunity was firstly disseminated through the portal of DERri and then with announcements in journals and specialized publications, not neglecting, for their major effectiveness, the direct contacts and the presentation in conferences and workshops.

User Selection Committee (USC) assessed and selected the submitted applications. Members of the internal Scientific Board and members of the External Advisory Panel, this latter constituted by experts from the Education and Industry worlds, formed the USC. The criteria of evaluation concerned the Technical merit of the proposal, the compliance to the EU policies and, in general the quality of the proposal and its technical/economic feasibility. It is worth highlighting a final assessment criterion, based on the impact of the proposed research on the knowhow and organization of the hosting facility, including a possible need of enhancement or adaptation of the facility technology and methods and/or synergies between laboratories. These latter aspects have great importance to DERri, as they manifest the cooperation willingness of the laboratories and their availability to growth, learning from the user projects experience.

The proposals approved by the USC for execution became User Projects (UP) and were implemented in the facilities of DERri. The choice of the most suitable laboratory for each UP to be implemented, was agreed among the partners, basing on the UP requirements, the availability of the installations and the preference of the users team.

The access of the Users to the labs was free of charge, with reimbursement of their costs for travels and accommodations, as preliminarily agreed in the contract with the host. Users were requested to deliver, at the end of their experience, a technical Report and to care the dissemination of the results of their research. Also the host laboratory was requested to report on the experience, for its own and of the DERri consortium benefit. It is a fact that the laboratory had to complement the user technical report with the parts concerning the execution of the tests, highlighting possible difficulties encountered, e.g. for lack of technologies or unavailability of consolidated methods. He was also requested to give a final appreciation of the TA experience through a dedicated questionnaire. Technical Reports and Questionnaires are available in the DERri website for internal use. Scope, objectives and main results of each implemented UP are synthesized in a factsheet published in a special section of the DERri website.

In overall, as many as 64 proposals were submitted through the portal and followed the described assessment and implementation procedure. Only a couple of them were rejected by the USC for evident inadequacy. The most of them were assessed as “good”, whilst a conspicuous number was even classified as “excellent”. The User Projects covered a wide range of the typical disciplines of the Smart Grids transformation, as shown in the following table.

User Project	Active Grid	ADART-EMM	AFPM-W-H	CA-VPP	CoLeadSuCapa	C-PoS FRT	DEIAGrid	DEMOC	DEMS	DEMSPV	DER_Management	DEVAGRA	DIRECT	DISCOSE
Active Distribution Control	■						■	■			■	■	■	■
Communication														
Data Metering		■												
Demand Side Management														
Emissions Control				■										
e-Mobility														
Energy Management			■			■								
Fault diagnosis									■					
Fuel Cell														
Microgrid											■			
Power electronics										■			■	
Protection Devices														
RES PV										■				
RES Wind Generator			■			■							■	
Smart Home														
Standardization			■											
Storage/Batteries					■	■								

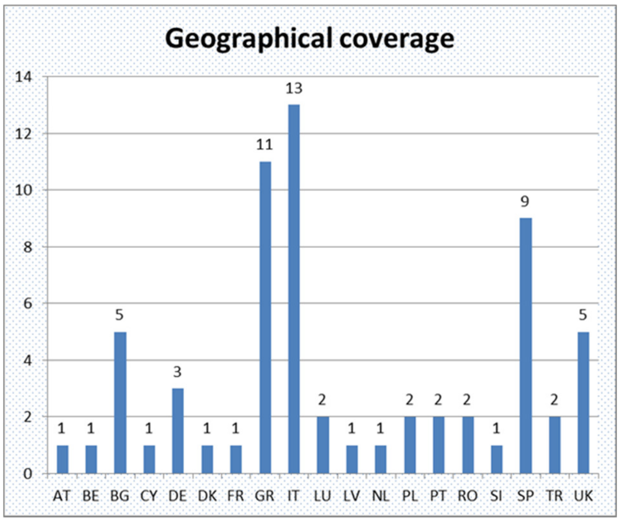
User Project	DPDinv	EFFICO	EMC-PV-M	ETAIzmir	EVOLVE-MAS	FORENTER	FRECLE	GSSSi-EDU	IGDySMoV	ILM	Interaktif	ITEH	MASGrid	MAVISIS
Active Distribution Control					■	■	■		■	■		■	■	
Communication								■						
Data Metering			■											
Demand Side Management							■							
Emissions Control														
e-Mobility					■									
Energy Management						■				■		■		
Fault diagnosis														
Fuel Cell														
Microgrid														
Power electronics	■			■					■		■			■
Protection Devices														
RES PV		■									■			
RES Wind Generator											■			
Smart Home														
Standardization														
Storage/Batteries			■											

User Project	MICROEFIRED	MiWEM	MoDERN	ModVal	MoreMODERN	OSMOTIC	PEMFCOLD	POLSAR	PRIME+DER	PV POWER	PV-APLC	RESSIC	RLICHARGE	ROSEDN
Active Distribution Control	■	■	■	■	■	■			■	■	■	■		■
Communication		■						■						
Data Metering														■
Demand Side Management														
Emissions Control														
e-Mobility									■				■	
Energy Management														
Fault diagnosis														
Fuel Cell							■							
Microgrid	■	■	■		■	■								
Power electronics				■										
Protection Devices														
RES PV				■						■	■			
RES Wind Generator												■		
Smart Home														
Standardization														
Storage/Batteries												■	■	

User Project	SEM-BAD	SMOOTHING	SOMMCC	SOPC_Microgrids	SPS-LPQDS	SPVSYS	SREI-MG	SWT-AFPM	TESCABI	TSFCLR	VC-81	VOREGLOC	W&S_IC	WOLEVET
Active Distribution Control			■		■	■					■	■	■	
Communication														
Data Metering														
Demand Side Management	■						■							
Emissions Control														
e-Mobility														■
Energy Management	■						■	■						
Fault diagnosis														
Fuel Cell														
Microgrid			■	■										
Power electronics									■		■	■		
Protection Devices										■				
RES PV		■				■			■			■		
RES Wind Generator								■					■	
Smart Home	■						■							
Standardization								■						
Storage/Batteries		■											■	

Map of the topics of the Transnational Access User Projects of DERri

Clearly, because of the peculiar nature of the laboratories consorted in DERri, a higher amount of the UP concerned the integration of DER, their impact on the grid in terms of management and control needs.



Most of the proposals (70%) came from Research and Education organizations, as expected. However, a high percentage (22%) came directly from industry, confirming once more the importance of the Research Infrastructures as a support of the European industry developments and competitiveness.

The geographical coverage of the submitted proposal is also remarkable: it is a fact that research teams accessed DERri from 19 different EU countries. Some countries (namely Italy, Spain and Greece) are more largely represented and this is presumably due to a more direct dissemination action of the corresponding partners in DERri.

The different laboratories of DERri were not equally involved in the Transnational Activities implementation. In some cases the laboratories were engaged well beyond the expected use at the beginning of the project, whilst some other were largely sub-exploited. Many factors influenced this result: the fame of the laboratory; the awareness about the potential; the available equipment; the geographical and cultural context; etc.

In some cases, the requirements of the project were such to make it possible a strict cooperation of different laboratories, in the same country (e.g. CRES and ICCS) or even in different countries (e.g. ICCS and EDF).

In other cases, the execution of the User Project gave a practical opportunity to set up innovative testing methods (e.g. the Power Hardware in the Loop), which will find full deployment beyond DERri, thus increasing the service portfolio of the laboratory.

As natural, not all the User Projects succeeded in the implementation at the facilities. About 20% failed due to different causes. In few cases, the users gave up before starting the experience because of difficulties in programming the visit to the labs for incompatibility with the normal work scheduling of the host organization. In the most cases, the execution of the User Project revealed practically unfeasible due to intrinsic difficulties, although theoretically it was. The typical case was when the user requested to implement, for a validation, his own developed control systems and to experiment them in the real host facility. This approach normally faced against the safety rules of the host organization.

Other situations of difficulty were reported in the mentioned Hosting experience questionnaires: typically hampers to a linear implementation of the projects were referred to their ambitiousness, e.g. revealed too expensive or time consuming for the host laboratory; to the lack of expertise of some Users, often young students, unpractical with the matter and the experimentation problems; to the unsatisfactory deepening of the technical problems and of the necessary testing procedures; to the immaturity of the technology under test, not ready for a real experimentation; to the unexpected failure of the specimen under test; to the excessive length of the preparation works; to bureaucracy issues, especially when dealing with host laboratories not used to commercial services; etc.

All these problems of technological and non-technological nature, far from being only troubles, constitute, in practice, a precious experience baggage, a profound lesson learned, both for the users and for the host organizations. It is a fact that they may represent typical hampers beyond the specific case of DERri, requesting care by the laboratory and being matter of work to enhance the quality and quantity of the offered services. Sharing this kind of problems at the level of DERri (and also of DERlab) is certainly an added value of the project.

It is worth pointing out that the execution of a project resulted in some cases an opportunity for the career of users (e.g. the case of a User employed by the laboratory at the end of his project) or an occasion of a collaboration of institutions (the one of the user and the host laboratory) after and beyond the DERri experience.

In conclusion, about 100 users benefited of the DERri opportunity under the TA initiative, having access to the installation for almost 800 days in overall and staying for a total of more than 1350 days at the DERri facilities. The average of the use of the installations was about 15 days per implemented project.

These durations are relatively small for research projects: they could be typical of experiments at the final stage of development. This presumably reflect, in the view of the Commission funding the projects, the need of sharing as much as possible with the available fund resources the opportunity offered by the TA. However, this short duration could be a further hamper to the full exploitation of the laboratory, especially in case of technologies and studies at the lowest readiness levels.

Full details concerning all the User Projects are included in the Deliverable D_NA-1.6.

The following conclusive remarks about the Transnational Access in DERri are worth, revealing the impact of the experience on the participating labs:

- TA activity was a good opportunity to share and implement common procedures, which may become a reference for all experimental activities (internal and external) beyond the DERri occasion
- These procedures, together with the methods specifically implemented to fulfil the user requirements, will hopefully the quality and the quantity of the offered services portfolio
- The quality of the proposals is an index of the deep interest of the European research and of industry in the Smart Grid evolution and, consequently, the importance of the availability of suitable and specific Research Infrastructures
- The TA experience allowed the involved laboratories to acquire sensitivity on the access criticalities and awareness on the safety and organization. In some cases this DERri experience revealed the importance of the operating costs and the need of an adequate control

In conclusion, the TA experience in DERri, together with the parallel networking and joint research activities, really strengthened the cooperation capacity of the European Research Infrastructures

2.1.1 *Supporting Transnational Access via website*

Some sections of the DERri portal (www.der-ri.net) were specifically dedicated to the TA activities, providing the potential users with an easy online application tool to submit their proposal in response to periodic Calls for applications. The portal was implemented in strict connection with Work Packages NA3 "Set up a User support service" and NA4 "Information and Dissemination".

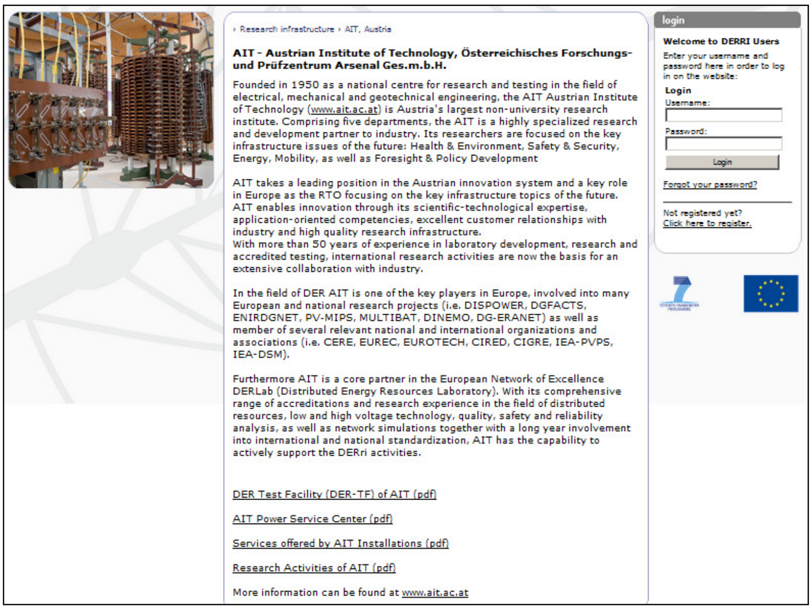
The Networking Activity NA3 was mainly concerned with general project support through the set-up and maintenance of the DERri project web site.

Regarding the Transnational Access, the specific objectives of NA3 were to:

- Setup an efficient and sustainable structure for a user service, which provides a single WEB-based entry point branching out into portals that address the needs of the different user groups and connect them to the relevant Infrastructures.
- Provide a portal for researchers with information on the capabilities of the facilities, assisting them in applying for ACCESS, accompanying them during their projects and advising them on the dissemination and/or exploitation of results.
- Install a public outreach program that supplies educators and students with material and provides "educational" access to the facilities.

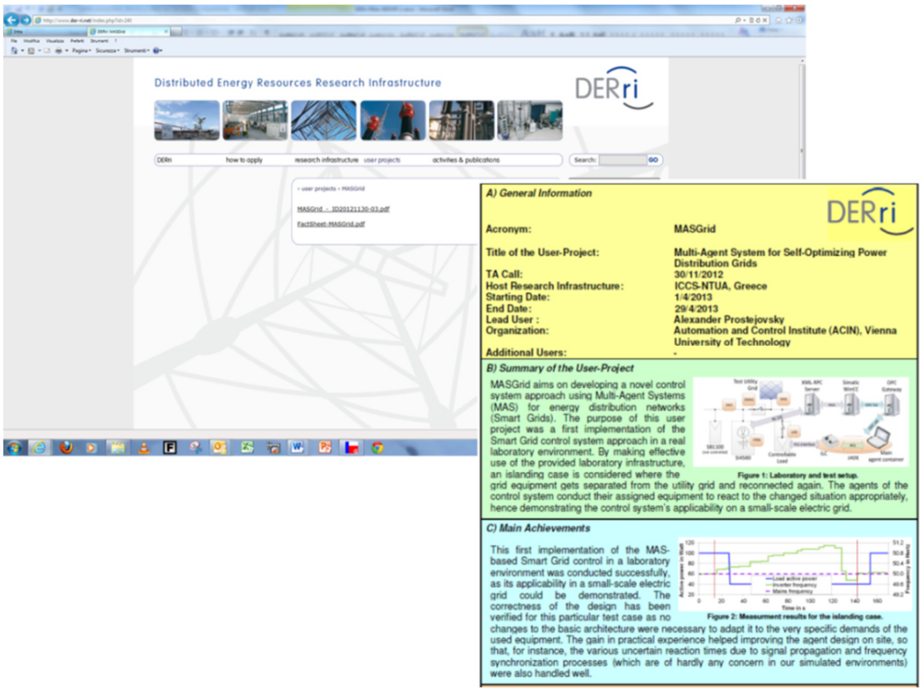
To the extent of supporting Transnational Access, four dedicated Sections of the portal were implemented, shown in the following figures:

- **Presentation of the DERri testing facilities and their research focus:**

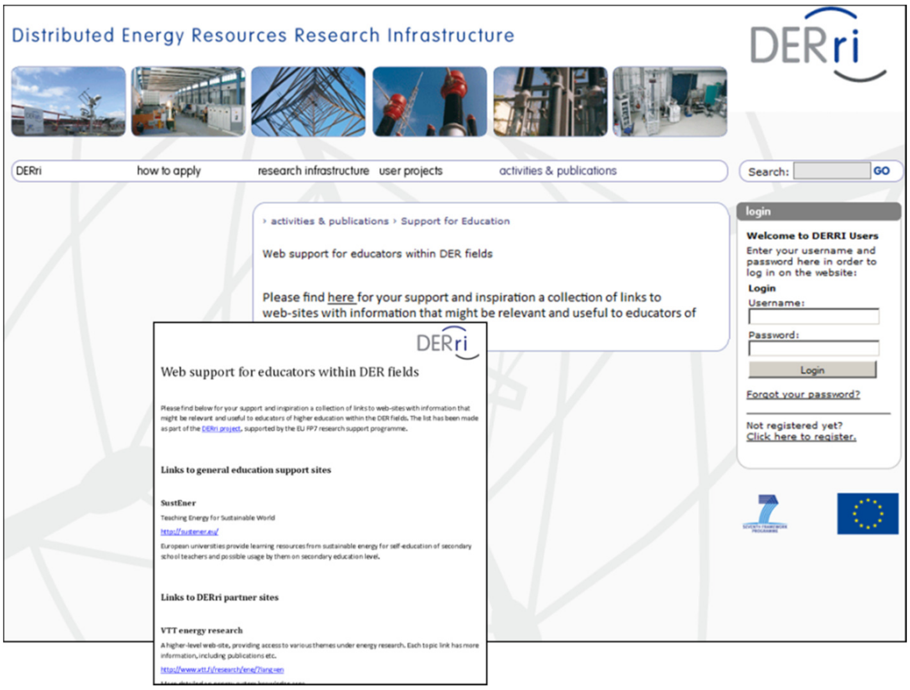


- **Disseminating Transnational Access opportunity and Supporting the on line application:**

■ **Disseminating the results of the User Projects:**



■ **Supporting users and educators:**



2.2 TECHNICAL NETWORKING: DEFINITION OF COMMON STANDARDS AND PROCEDURES

Main Author: Christoph Mayr (AIT – NA2 Work Package Leader)

The facilities that compose the DERri infrastructure are operating in the same research field and therefore present several similar aspects and analogies. Far from being a problem, the apparent overlapping in the facility characteristics is, in fact, a considerable advantage. Similarities among different facilities allow verifying and comparing different realizations of similar conceptual schemes. The experiments carried out in the laboratories of the DERri community will provide results that can be put in comparison on the same scale. Furthermore, a stronger collaboration permits to reach out and engage more effectively with external stakeholders, such as industries, research and standard bodies, schools and educational institutions etc

Finally, the cooperation brings advantages for result communication and dissemination, cross-fertilisation and will result in the growth of a stronger European research community.

NA2 addressed an important issue for users of the large facilities, the reliability of the activities performed in each facility, their traceability and their reproducibility. Many factors influence these features: e.g. the adoption of different reference, standards, methods and procedures; the use of different equipment and instruments; different standards of quality; skill and expertise of the operators and also the vocation of the infrastructure: scientific approach or commercial goals.

This Networking activity aimed at creating the conditions to guarantee that experimental tests on the same samples repeated in the same laboratory lead in principle to the same results.

A further target of the activities was the definition of a portfolio of typological services provided by the infrastructures and the mapping of each infrastructure over this portfolio. The intent was, in a effective cooperation context, to identify the facility most suitable to provide specific services requested by a user and to make this info available to the same user through a dedicated database.

The following Tasks of the Networking Activity allowed pursuing the objectives:

- Task 1: Organisation of networking seminars and workshops
- Task 2: General criteria for laboratory work and equipment management
- Task 3: Common protocol for research laboratory work
- Task 4: Development of common testing procedures and standards requirements

Within Task 1 networking seminars and internal workshops were organised. Workshops are deemed as strategic means for the integration of partners, for the sharing and discussion of results regarding activities of common interest as well as for exchange of good practices, procedures, quality standards and even laboratory/ equipment management aspects. Thus, the implementation of the Workshops also responded to training aims for the personnel of the DERri labs.

In overall, eleven Workshops were organized (DERri Milestone M_NA-2.1) covering all the themes pertinent with DERri. In some case the meetings included demonstrations of experimental applications of the DERri research activities. In principle, they were conceived as internal workshops, although the participation of external attendees was open.

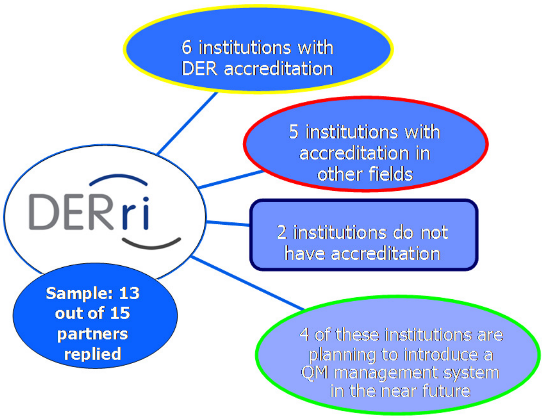
Date	Location	Organizer	Title	Concerned DERri activity
May 26th, 2010	Clamart	EDF-SA/IWES	Concept of virtual access to DERri infrastructure	JRA1
October 27th, 2010	Helsinki	VTT/AIT	Quality Management of laboratories	NA2
November 24th, 2010	Vienna	AIT	Technical Workshop: Real time simulation environment and parameter identification for power systems	JRA 3
November 17th, 2011	Vienna	AIT/RSE	First debriefing of the DERri Transnational Access: offer, cases, improvement	TA, NA1
April, 19th, 2012	Athens	NTUA/CEA	Filling the gaps in testing and characterization methods for DER power components: Storage Systems	JRA2.1
April 20th , 2012	Athens	NTUA/AIT	Hardware-in-the-Loop Workshop	JRA3
December 3th, 2012	Berlin	IWES	JaNDER development: progress and achievements	JRA1
April, 18th, 2013	Chambery	CEA/AIT	JRA2 - Large Inverters: Progress and achievements	JRA2.2
April, 18th, 2013	Chambery	CEA	JRA2 – Storage Systems: Progress and achievements	JRA2.1
April, 19th, 2013	Chambery	CEA/AIT	JRA3 – Progress and achievements	JRA3
April, 19th, 2013	Chambery	CEA/IWES	JRA1 – Progress and achievements	JRA1

Presentations and outputs of the Workshop were included in the public Deliverable D_NA-2.1.

Task 2 specifically dealt with quality assurance aspects, with the intent to propose a flexible management model based on common procedures for performing tests in infrastructure facilities, as required in order to assure results accuracy and comparability. The most important elements for ensuring comparable test results are:

- competent personnel,
- well documented methods,
- traceable calibrations,
- control of the measuring data
- internal and inter-laboratory benchmarking.

A review of the Quality Management Systems and reference Standards adopted by DERri partners was compiled, based on the “questionnaire on common rules for laboratories” distributed among the laboratories. The survey concerned the general quality assurance criteria and the state of their application in the Laboratories, as well as an analysis of the major deviations. The statistical evaluation of QM systems in operation at DERri laboratories is shown in the hereinafter Figure.



The following 'Quality Management System and Standards' are used (in brackets the number of concerned labs)):

EN ISO 9001: Quality management systems - Requirements (8)

EN ISO 17020: General criteria for the operation of various types of bodies performing inspection (2)

EN ISO 17024: Conformity assessment - General requirements for bodies operating certification of persons (1)

EN ISO 17025: General requirements for the competence of testing and calibration laboratories (in total 8 and specifically 6 for DER-testing)

The conclusions of the survey (summarized in the Deliverable D_NA-2.2) showed that the spectrum is broad: from no accreditation up to very sophisticated QM procedures. In summary, the discussion clearly reflected two distinct groups, educational-orientated (academia) and customer-oriented laboratories, both with different objectives and requirements. Academic laboratories are focussed on dynamic approaches making use of the full range of options that their laboratories allow for; customer-oriented laboratories are more focussed on the requirements prescribed by standards and accreditation rules in order to satisfy the criteria of accuracy, reliability and repeatability of results.

It has been shown that the laboratory work of educational institutions and research laboratories being part of public universities is focusing on the training for students, the development of methodologies and the general assessment of the overall system behaviour. On the other hand, test and research institutions with scientific and commercial aims are rather interested in providing highly accurate test results for customer-oriented product testing (e.g. efficiency measurements). Of course different requirements for accuracy of results greatly affect the framework conditions in terms of flexibility of testing, calibration intervals, prescribed testing schemes, etc..

The Deliverable D-NA2.3 reports on the analysis done. A short summary of the common protocol and minimum requirements for the laboratory work (minimum requirements with minimum costs and minimum management effort) agreed by all DERri partners (also for those not having an accreditation in DER-field) is given in the following table (DERri Milestone M_NA-2-3).

Common protocol and minimum requirements
• Creating awareness of the importance of QM also at educational institutions, taking into consideration elements of the IEC 17025
• Education and training of personnel, skilled personnel working in laboratories
• Having available relevant standards and related documents, being aware of state-of-the-art testing methods

Common protocol and minimum requirements
• Use either standardized or well documented methods for performing the tests
• Documented test setup, ideally fixed configuration with reproducible variability (core setup, with extensions) e.g. describing all of the devices once, unchecking the components not used.
• Use of adequate measuring equipment with standardized measuring methods implemented (e.g. Flicker measurement)
• Check precision of measurement devices (Calibration or comparison) and performing an uncertainty assessment at least once
• Use automated testing approaches as far as possible
• Computer assisted test evaluation
• Harmonized test reports, use the same template for all activities in the same laboratory

With the overall aim to achieve mutual specialisation and to strengthen the complementarities between the partners, Task 4 of Work Package NA2 focussed on three aspects: definition of the testing portfolio made available by the laboratories consorted in DERri; presentation of labs features and portfolio in an open Data Base (Milestone M_NA-2.4) and performing of round robin tests involving DERri labs (Milestone M_NA-2.5).

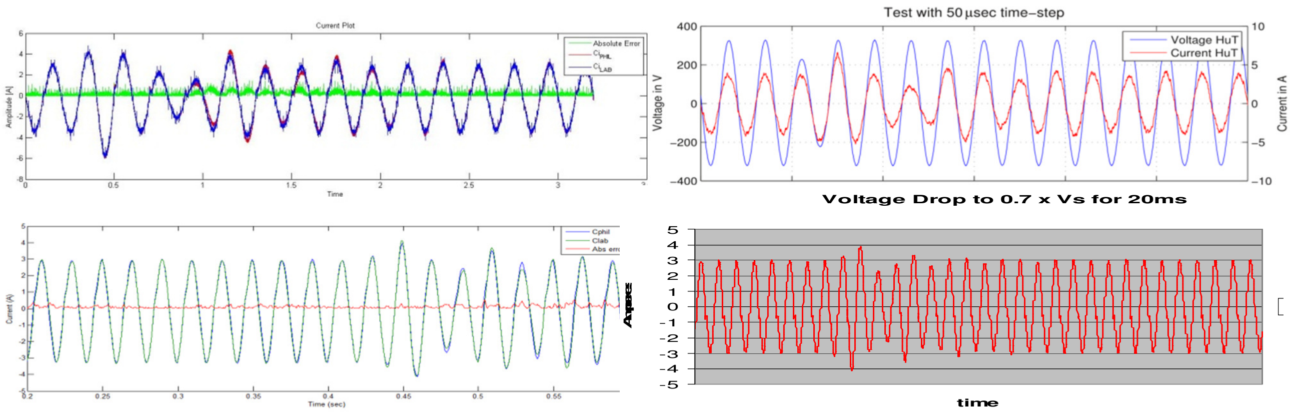
The portfolio analysis put in evidence the great complementarity of the DERri labs in the field of Smart Grid Testing, as shown in the below Table.

	High Voltage/ High Power	Power Quality & EMC	Hybrid Systems/ Micro Grids	Power Electronics/ Inverters	PV Systems	Wind Systems	Storage Systems	Comm. Tech. & Smart Metering	Fuel cell Systems	Biomass systems	Electrical vehicles	System Security and Reliability	Smart Buildings
AIT	•	•	•	•	•		•	•			•		•
TUS-RDS	•	•	•	•	•	•	•	•					
IWES		•	•	•	•	•	•	•	•	•	•		•
DTU	•	•	•	•	•	•	•	•			•		•
VTT		•	•	•		•	•		•			•	
CEA INES			•	•	•		•				•	•	•
EDF	•	•	•	•	•	•	•	•			•		•
CRES		•	•	•	•	•	•	•	•		•		
NTUA		•	•	•	•	•	•	•					
TECNALIA	•	•	•	•	•	•	•	•	•	•	•	•	•
RSE	•		•	•	•		•	•		•	•		•
DNV KEMA	•	•	•	•	•	•	•	•					
TU Łódź	•	•	•	•	•	•	•		•		•		
University of Manchester	•	•	•	•	•	•		•					
University of Strathclyde	•	•	•	•	•	•	•	•	•		•	•	

This portfolio was integrated into the database of DER and Smart Grid Research Infrastructure, hosted and maintained by DERlab Association. The database currently contains systematic information on more than 100 research infrastructures and related assets, testing capabilities and services made available by 33 research institutes, universities or companies from Europe and the US, which are focusing on Distributed Energy Resources (DER) and Smart Grids. The database can serve as a reference for researchers and industrial stakeholders who are looking for testing capabilities or the consultation of experts. It is accessible under the following link: http://www.der-lab.net/derlabsearch/public/index.php . Also the common protocol and minimum requirements above referred to can be downloaded from this database website.

The definition of common testing procedures is one of the key requirements to achieve an optimal use of joint infrastructure. To this extent a campaign of robin round tests was implemented, involving 6 laboratories of the Consortium. The scope of the tests was focused, in particular, on the demonstration of the feasibility of PHIL experiments at various DER Laboratories with different test equipment and the same Device under Test (DuT). The choice of the PHIL testing, as the topic of the benchmarking, is clearly related to the high strategic importance of this methodology, which is an effective and relatively less expensive way to combine real experimentation and simulation in the systemic demonstration of DER and smart equipment integration into the grid.

A number of test cases (6) for the experimental PHIL common test were defined. The setup may vary for different laboratories, corresponding to the availability of equipment. In spite of this, the NA2 common test showed that the different test cases, are fully reproducible at the different laboratories. This important result was extensively reported in the Deliverable D_NA-2-4.



Similar results of the same test case at different sites

The overall assessment of the portfolio analysis and of the round robin tests campaign was that a number of DERri partners are highly specialized in the field of testing large scale PV inverters and/or performing real-time simulations with a Power Hardware-in-the-loop approach. In particular:

- 4 out of 15 DERri partners have capabilities to test large scale PV inverters
- 6 out of 15 DERri partners have Real Time simulation and power hardware-in-the-loop capabilities.

	Smart Distribution Network Simulation	System Stability based on DER	Multiple-Systems interaction and dynamics	Single DER Component testing	Controllers of DER generation units	Controllers of electrical storage systems	Controllers of Wind Turbines / Wind Parks	Automation system equipment tests (e.g., IED, RTU, controller)
AIT	•	•	•	•	•	•		•
IWES	•	•	•	•			•	
ICCS-NTUA	•			•				
TU Lodz	•							
UStrath	•	•		•				•
CEA-INES	•			•	•	•		

Common research and test portfolios in the field of Real Time Power-Hardware-in-the-loop

However, only 3 DERri partners (AIT, IWES, KEMA DNV) are operating an infrastructure capable of testing also large scale PV inverters (although with some adaptations still necessary). This will enable an effective implementation of PHIL approaches and common tests in three different laboratories, leading to comparable and validated test results.

2.3 JOINT TEST FACILITY FOR SMART ENERGY NETWORKS WITH DISTRIBUTED ENERGY RESOURCES – JANDER

Main Author: Wolfram Heckmann (IWES – JRA1 Work Package Leader)

Distributed Energy Resources (DER) are – per definition – power generators, storage devices and controllable loads connected to the electric network. Typically the power rating of DER is much smaller than 30 MW per unit. Nevertheless, if controlled adequately, DER may provide energy services as seen in 'virtual power plants' as well as ancillary services (e.g. frequency control, local voltage control). Different kind of aggregation approaches may be used to provide energy and ancillary services of significant scale. There are already test facilities for distributed generation which may be used to study the performance and effectiveness of different aggregation approaches. However, a lack of standardised interfaces, as well as the many types of DER, with only few of them available at a single test facility, leads to limitations for testing of aggregation methods.

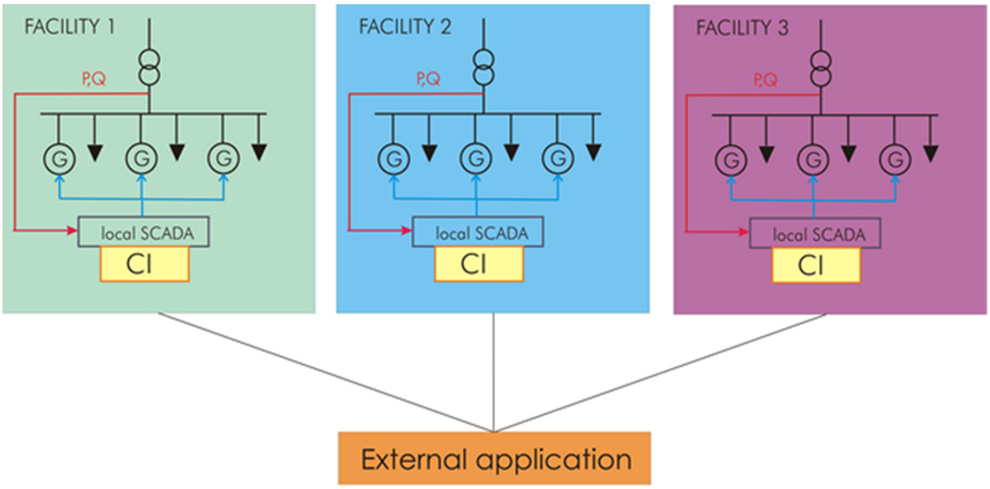
The overall objective of the workpackage JRA1 "Joint Test Facility for Smart Energy Networks with Distributed Energy Resources - JaNDER" is the establishment of a virtually pan-European demonstration laboratory with testing equipment linked with a single communication protocol serving as test bed for different combinations of technologies or aggregation mixes, and operating under innovative control schemes. JaNDER aims to improve and better utilise the existing test facilities and enables a high performance platform for research on the next generation electric networks.

Some of the advantages of JaNDER are:

- Remote access to each facility will be enabled by Internet capable communication.
- More units, but also a bigger variety of generator types, loads, storages devices as well as network equipment is available for research and testing. The already existing research facilities are complementing each other establishing a much more comprehensive research and testing environment for smart energy networks.
- Better utilisation factor of existing research infrastructures by improved access. Access and collaboration will be much faster and more efficient.
- Development and implementation of common, standardised interfaces for aggregators enables faster, more efficient research as well as faster access for both, academic and industrial users.

The approach followed by JaNDER is to add a common interface "CI" to the already existing custom SCADA system. This CI provides a common access to the facility, independent of the local custom SCADA. "Common" means here that the same set of information, same protocols, etc. are used at all JaNDER laboratories. This interface may then be used by new (or existing) management and control systems for smart electricity networks with DER.

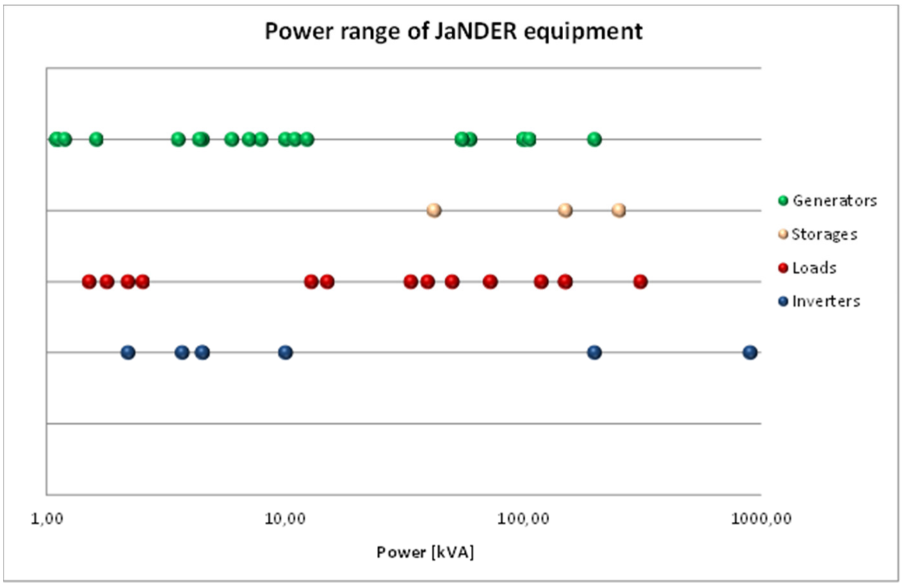
Any management and control system using the CI to access one facility should be able to operate at another facility which has also the CI implemented. In addition to this, parallel access should also be possible to manage and control several facilities at the same time from one application or to monitor and control a testing procedure in one laboratory from different remote places.



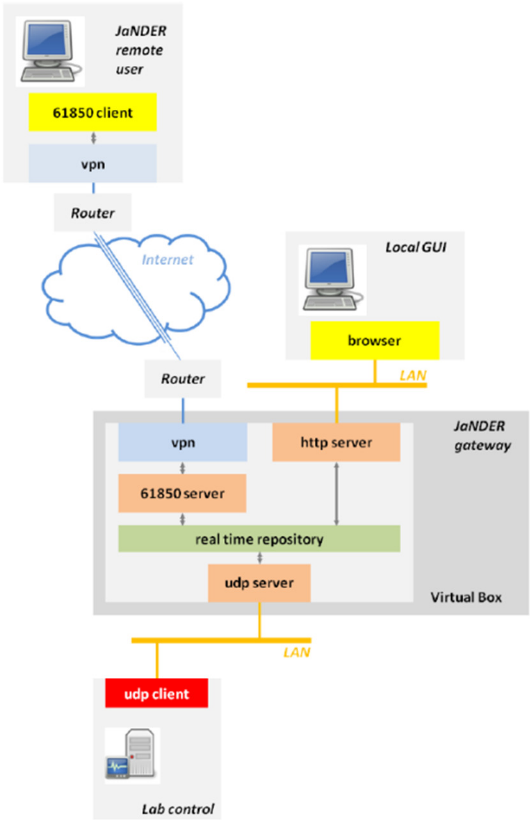
JanDER concept with parallel remote access

Information on the equipment among participating laboratories that can be connected via JaNDER architecture was collected in a data base. In addition, a description of control system/ SCADA used in each facility was prepared.

The available main equipment and its power ranges are summarized in the below figure. The majority of the devices are connected to 400 V AC 3-phase or 230 V AC 1-phase connection. The power ranges for different device types are illustrated in figure 4.3.2. A group of small devices for domestic applications can be seen easily (below 10 kVA 1-phase devices; for instance PV inverters). Similarly, a utility-size group can be found around 100 kVA scale (for instance micro-turbines and diesel gen-sets). The load sizes indicate maximum powers. In many cases they are controllable to meet also smaller power requirements and to be adjusted exactly to the load/ power needed.



Power range of the equipment available in the laboratories of the DERri consortium



General overview of the implementation of the JaNDER interface and the gateway connections

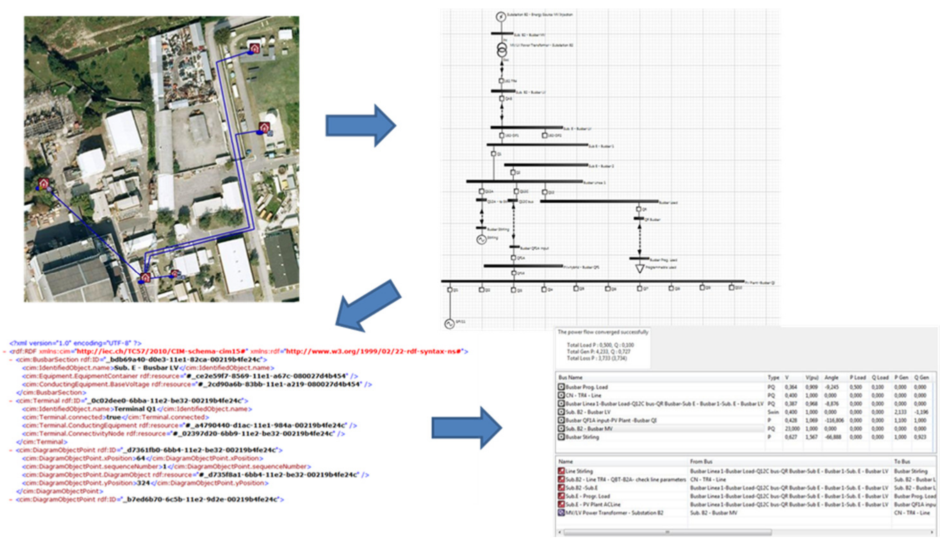
The requirements for the interconnection were specified taking into account different testing processes and security needs. The JaNDER gateway was implemented on the standard IEC61850 and a pragmatic solution, mostly based on available software packages. Its core is constituted by a gateway between the MMS protocol, peculiar to the above-mentioned standard, and a simple ad hoc protocol, XMC developed by RSE, to interface the testing facility from the local LAN. This gateway is contained in a virtualized disk image, configurable by each partner to comply his site needs.

For all partners it was a major effort to integrate the DERri JaNDER gateway into their existing communication infrastructure and in two cases the difficulties could not be overcome in the course of this project. The difficulties are related to protocols and data policies of the individual networks.

Additionally, a central SCADA system was implemented and the integration of hardware laboratories and simulation laboratory was successfully shown.

For the central SCADA system the interconnection to remote test facilities was set-up. The connection was live demonstrated at the final event in Milan monitoring the PV installations at RSE using the central SCADA.

For the hardware/ software laboratory integration the test facility infrastructure of RSE was modelled using CDPSM (Common Distribution Power System Model) and successfully integrated in the Digital simulation environment of EDF.



Modelling of the test facility network for the integration into the software laboratory

The specification for a laboratory interface to allow virtual interconnection of test beds was developed. Security aspects are laid down. A real time capable interface was developed and implemented in the different laboratory environments.

For the validation of the JaNDER concept and set-up, use cases were defined, performed and test reports were produced. The use cases comprise the whole range starting with the connection testing and evaluation of the quality of the interconnection to parallel monitoring of tests and remote control. A number of thirteen tests were defined altogether. The tests were individually specified and validation criteria defined.

The use cases were successfully performed, except for two facilities. For these two facilities the use cases could not be performed due to communication restrictions between the gateway and the laboratory network or equipment respectively that could not be overcome in this project.

The validation tests cover the performance of the communication channel, the monitoring and the control of remote test procedures.

Use case class	**Use case title**	**Involved DERri partners**
Real time remote monitoring	Remote connection to the JaNDER Gateway installed in Tecnalia through IEC 61850 client and Web Browser	Tecnalia
Real time remote monitoring	Test the performance of the Web Based connection to the JaNDER gateway, Response time and concurrency test	Tecnalia
Real time remote monitoring	Connection Monitoring	IWES, Tecnalia, RSE, CRES, University of Strathclyde
Real time remote monitoring	Test of data coherence between the JaNDER gateway and the remote client	Tecnalia, RSE
Real time remote monitoring	Test the JaNDER gateway under different failure cases, mobile coverage, JaNDER shutdown	Tecnalia
Real time remote monitoring	Evaluate the correctness of the remotely acquired measurements, confronting them with a local copy	TU Lodz, RSE
Real time remote monitoring & Real time remote control of a test procedure	Efficiency performance test of grid-connected, lead-acid battery storage system, parallel monitoring and remote control	CRES, AIT, RSE, ICCS/NTUA
Real time remote control of a test procedure	Tuning of an oscillatory circuit in a test bed for PV-inverter tests	AIT, CRES
Real time remote monitoring & Real time remote control	Remote connection to the JaNDER Gateway installed in TUS-RDS through IEC 61850 client and Web Browser	TU Sofia, RSE, CRES
Real time remote monitoring	Central SCADA functionality evaluation	TU Lodz, RSE
Real time remote monitoring & Real time remote control	PV Monitoring, Battery Monitoring & control, transition to island mode	ICCS/NTUA, CRES, AIT

Successfully performed validation tests/ use cases

The evaluation of the connection monitoring use cases delivered the following insights.

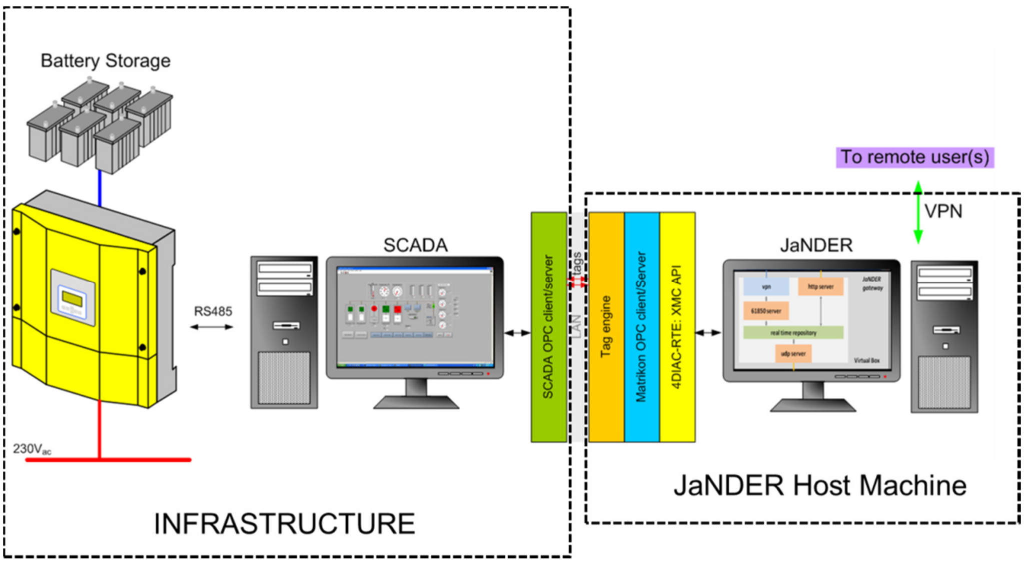
The performance of a telecommunication system can be described by quality of service (QoS) parameters including e.g. latency, jitter, and packet order or packet loss. Acceptable values of these parameters must be extrapolated from the overall, high level requirements of the specific use case being tested, which are often expressed in an informal and not ICT-oriented fashion.

One example for the latency and another for the data polling process is given here. In the preparation of the JaNDER concept a study was performed on the acceptable latency of the communication between virtual coupled test facilities. The study showed that a response time up to one second would be acceptable for laboratory purposes if the focus is on steady state analysis and transient phenomena will not be investigated. Furthermore, the validation has shown that the resolution of the data polling must be considered judging the permitted response deviation.

The most advanced use cases regarding the virtual access to a testing facility were

- the remote control of parameters of anti- islanding testing,
- the remote control of the transition to island mode of a PV-battery system, and
- the parallel monitoring and remote control of the performance testing of a storage system.

The latter test consists of two legs. The first one (basic scenario) regards the remote supervision and control of one of the battery storage systems located at CRES facilities in Pikermi-Athens, Greece. The selected system consists of one lead-acid battery bank connected to the grid via single-phase inverter. The objective of this case is to perform using JaNDER the round-trip efficiency as described in the DERri deliverable JRA2.1 (Criteria and procedures for performance testing). The selected test regards one cycle of operation (discharging/charging) during which, the state of energy (SOE) will vary between 80 and 100%. The monitoring of the real power will provide the user with information about the status, while local measurements of the AC and DC power provides data for the round efficiency calculation.



Remote control of an efficiency performance test of grid-connected, lead-acid battery storage system

Operation of the battery storage during a full test cycle. Left hand: Response of the inverter output to set-point remote changes. Right hand: Data recorded by one of two remote clients and by the local SCADA

In addition to the above described test, the second leg of this case is a parallel monitoring test performed using the above facility, with the participation of RSE and ICCS/NTUA as connected clients which had the possibility to monitor concurrently the operating state of the battery storage unit.

The remote monitoring and control of the battery test stand and two other remote connections were also demonstrated in public at the occasion of the DERri final event.

A real time capable laboratory interface for connection of remote test facilities is available. The appropriateness and performance of the common virtual access, the DERri JaNDER gateway, for the remote monitoring and control of individual units of a distributed testing facility were validated through selected experiments. The interconnection via the JaNDER gateway allows for a better utilization of specialized research infrastructures and for long-term tests. The validation tests of the remote testing procedures have shown the capability to perform a test in mixed teams where some team members are not located in the testing facility where the physical test takes place. Tests were successfully performed with single client monitoring and control and multiple client monitoring.

The interconnection of the testing facilities via the DERri JaNDER gateway is paving the way to a virtual laboratory (or e-infrastructure) allowing for a better utilization of specialized research infrastructures and facilitating long-term tests or field trials.

The validation test “Efficiency test of grid-connected, lead-acid battery storage system” is an example how European collaboration is facilitated by the new monitoring and control capabilities. In the DERri project one task was to develop a procedure for the performance testing for such a system. Not all of the partners have the test facilities available to verify this procedure, but via the JaNDER gateway it is possible for all interested parties that developed the testing procedure to fol-low the test and see the results live. Thus this system is fostering and enhancing the possibilities of collaboration.

Additionally, the use of the JaNDER gateway is not restricted to inter-laboratory communication but will also be applied to field trials for remote and long-term monitoring of devices.

2.4 FILLING THE GAPS IN CHARACTERISATION METHODS FOR POWER COMPONENTS

Main Authors: Nicolas Martin (CEA – JRA2.1 Workpackage Leader and JRA2.1 Task Leader)
Roland Bründlinger (AIT – JRA2.2. Leader)

JRA 2 builds on the need to clarify the performance criteria and the associated characterisation methods for DER components to be connected to smart electricity grids. The developed testing methods will be used in the test platforms of the DERri infrastructures, thus improving the quality of the access provided to their users.

Among the many different types of DER components, the focus was laid on the following two types of components, for which the largest gaps in existing test and characterisation methods were identified:

- storage systems: the performance criteria and testing methods are well defined for the traditional applications of storage, such as uninterruptible power supply (UPS) or stand-alone configuration, but this is not the case for grid-connected storage systems, used for grid support, power quality, load levelling etc.
- large-scale RES inverters: originally mostly focused on the low-power range, the unit capacities have been growing significantly in recent years. Modern inverters require adequate testing capabilities, which include not only laboratories but also expertise and common testing procedures. These procedures need to take into account the new characteristics, features and possibilities of modern power electronics.

Through their unique specificity of being at the same time power supplies and load management systems, electricity storage systems are key components to enable the transition towards higher shares of DER in the electricity grids. Storage systems can be installed and shared at different levels from central installations (several hundred MW) to dispersed installations across the networks or at the customer (from 10 MW down to the kW range, for instance plug-in hybrid cars).

These applications are very different in terms of operating constraints, and the sizing and storage technology selection will need to be adapted to these constraints. The selection of the best suited storage for a given application needs to be based on precise criteria and associated test procedures. These are well defined for the traditional applications, such as uninterruptible power supply (UPS) or stand-alone configuration, but this is not the case for grid-connected applications. Especially in this context, storage systems can be operated in “energy mode” (e.g. Energy Time shift) or in “power mode” (e.g. Power Balancing, Power Ancillary Services).

Specifically for large-scale inverters, which have been growing significantly in capacity as well as in innovative functionalities thanks to the rapid development and significant cost reduction of power electronics in the recent years, the pressing need for a dedicated testing environment to fully assess their performance was identified. In addition, also the lack of appropriate characterisation methods resulted in various problems being faced by large DR installations.

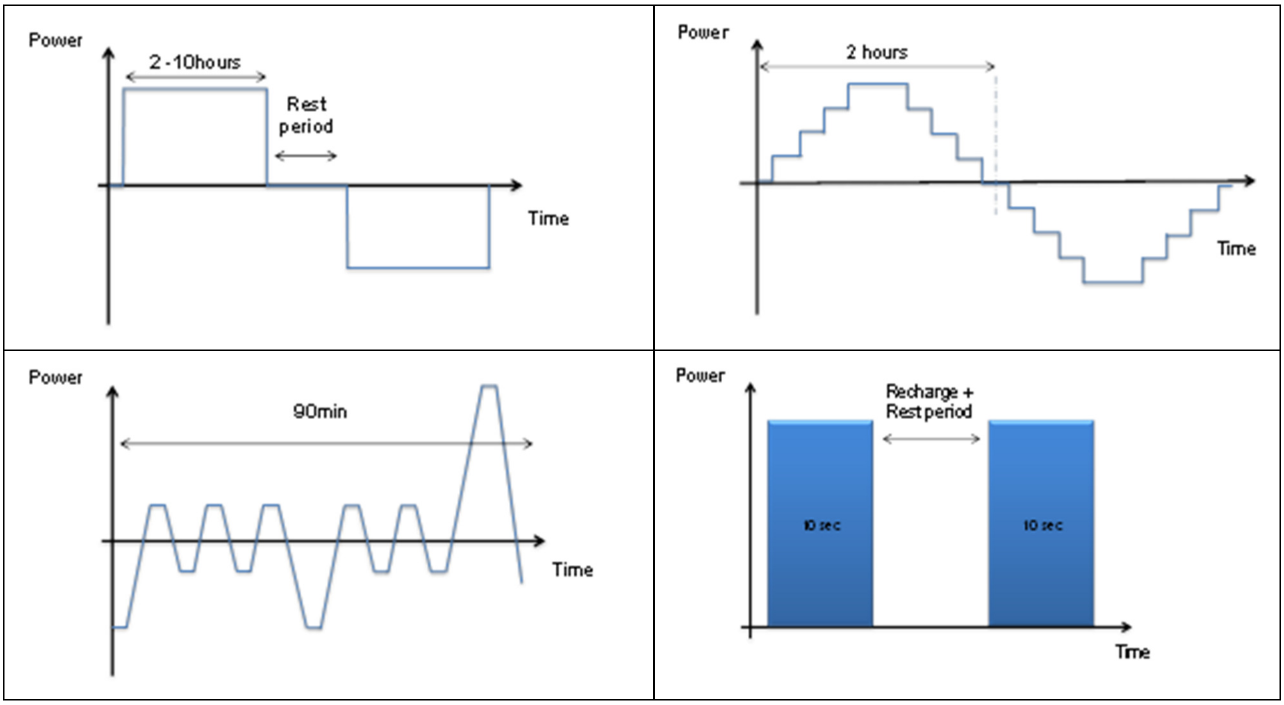
The result is often an increase of the time-to-market for new products, since they currently have to be evaluated in long-term field tests. On the other hand, final optimisation with respect to the product’s performance as well as the “active” role that modern power electronics could play in the grid was often hindered by the lack of available test capabilities.

2.4.1 *Storage systems*

Following the overall objectives of JRA2, namely to develop performance criteria and the associated characterisation methods for DER components to be connected to smart electricity grids, JRA2.1, targeting storage systems, aimed at responding to the following questions:

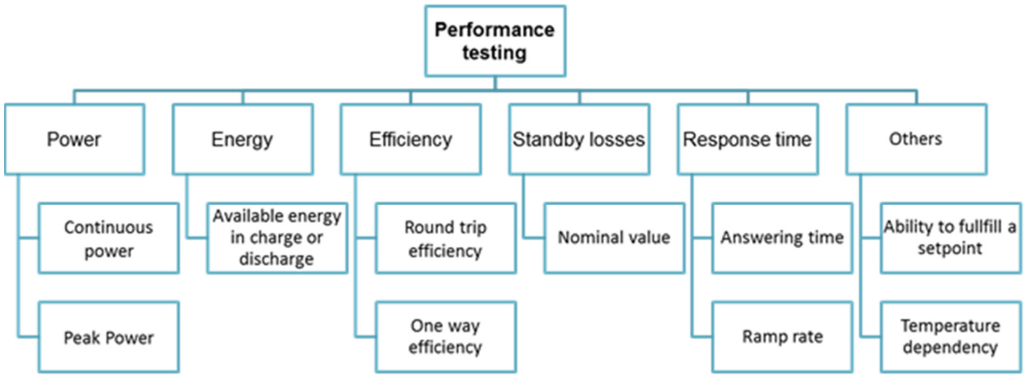
- What are the most pertinent applications of storage in electricity grids and their specificities?
- What are the important performance criteria for these applications?
- How to measure, estimate or assess them?
- How to predict the storage life time in these applications?

Among all the potential applications of storage in grid-connected configuration, the first step has been to cluster the applications looking at their similarity from a storage point of view we look at the storage power profile characteristics more than the grid services associated). In this way, we defined 3 pertinent clusters and their associated criteria of interest and the associated use profiles (time shift, power balancing, high power applications). We also made a first analysis in order to determine the main storage technologies that could be candidates for each application.



The 4 typical duty cycles related to grid connected storage applications

The second step has been to identify the existing lack in performance characterization on each of the criteria of interest and to propose new or updated procedure. Our approach focused on how to characterize an Energy Storage System (ESS) in order to extract useful information for grid system investigation. Following the definition of the tests procedures, we apply them to five ESS available within the consortium in order to get experience feedback and to adapt/correct the procedures. We also compared these results to the manufacturer datasheet in order to evaluate the pertinence of the existing datasheets.



Listing of the performance criteria

The third step has been to identify existing methods for lifetime prediction, to identify the gaps in testing. Because the existing procedures do not measure the loss of performance regarding the important criteria, we propose a methodology in order to estimate lifetime/performance degradation of energy storage systems.

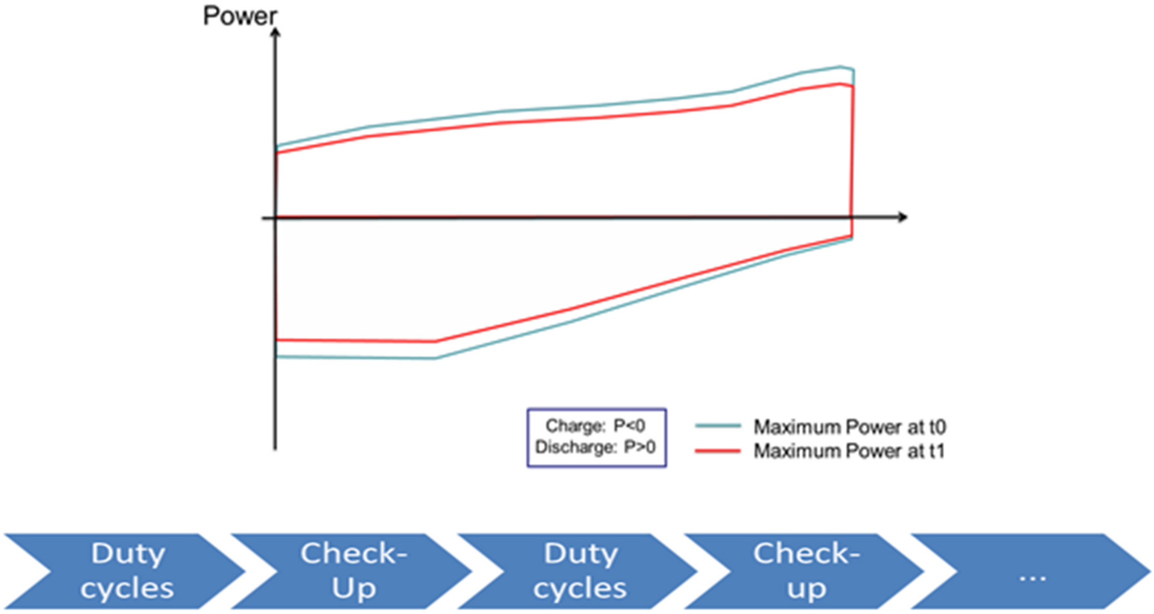


Illustration of the maximum continuous power available evolution for two check-up at different time of the life of the ESS

Finally, the work performed within these 3 first tasks into a set of "guidelines for testing grid connected storage systems" was summarized.

During the first task (clustering of applications) of our analysis, we proposed the "storage point of view" concept. Indeed, from a "grid point of view", it is possible to select and cluster applications looking at, e.g.:

- their location on the grid (e.g. End user, distribution network…);
- the amount of energy or power required;
- the kind of service requested (energy, grid support…;
- the added value to the grid.

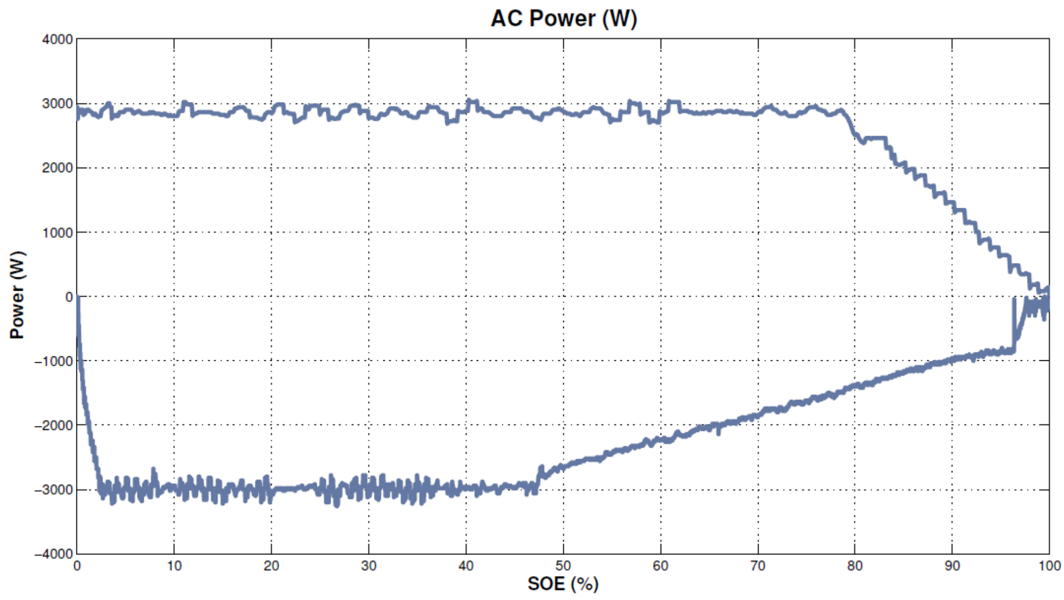
This kind of approach is very familiar in the literature but not so much useful for our topic. In the present work, among all these different ways to cluster applications, we are focusing on the similarity between applications on a “storage point of view”, i.e. looking at the solicitation of the storage. This is characterized by the fact that we do not look at the:

- Sizing of the application: for example, we do not consider any differences between peak shaving applications for end users or for a transmission substation (even if the difference between the two storage sizing is huge).
- Location on the grid: the frequency and the kind of ancillary services will be different depending on the location (distribution substation, end user…). We do not take into account this factor.
- Added value to the grid: for example, investment deferral application has the benefit to avoid system upgrading and Electric energy time shift allow us to earn money depending on the electricity market. As different as their added value could be, the storage system solicitation is very similar (i.e. we store energy for a couple of hours for then discharging it later).
- Starting from these assumptions, we selected and clustered applications looking at different storage solicitation criteria and so we simplified a lot the problem related to the diversity of applications.

For the second step of our study, we identify large gaps in characterization. Indeed, most of the datasheet do not propose adequate information for grid connected applications. Furthermore, datasheet are generally not available at the system level (including electronics, conversion…). Based on the storage system operator needs, we defined new procedures. We describes below the two ones where the largest gap has been identified.

Power

The classic approach consists to define the storage system power as the power conversion power. This is clearly not useful for a complete knowledge of the storage system behaviour. In the way to fill this gap, we propose a procedure allowing to improve power characterization.

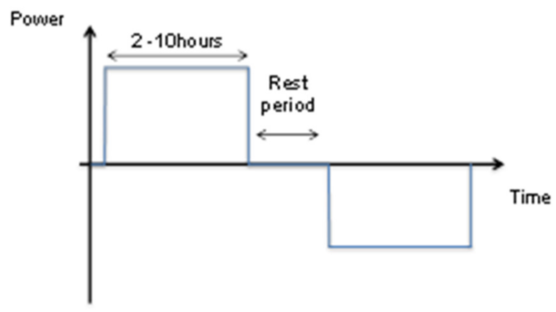


Power as a function of the state of energy of the storage system (measured on the Lead-acid NTUA storage system)

Efficiency

The classic approach measure the round trip efficiency for a complete cycle (full charge- full discharge). We proposed to measure this round trip efficiency regarding partial cycle operation. We also propose to estimate the one-way efficiency as it could be very useful to know how much energy is stored (not charged) in real-time.

For the last step of our analysis (related to lifetime), we proposed a methodology in order to estimate how the performance will degrade. Usually we defined the lifetime of storage systems as a certain loss in terms of performance (20% loss of capacity for battery). Our approach proposes to evaluate how all the different performance criteria evolve during the lifetime of the storage system in order to let the storage system operator decides when it is technical/economically the most suitable. We proposed four classical duty cycles that could be used by storage systems manufacturers in order to aged their storage systems between two successive performance check-up.



Step	Round trip efficiency (charge 10kW-discharge 10kW)
Initial performance	80%
After 1000 duty cycle type 1	78%
After 2500 duty cycle type 1	75%

Example of results for performance degradation

Behind the impact within the consortium, this JRA2.1 activity should be useful for ESS manufacturers of for ESS operators in order to characterize and compare ESS each themselves. ESS indicators developed should also help ESS operators to improve their storage system operation in real-time and for maintenance purpose.

In this context and for the deployment of our methodology behind the consortium, we proposed our approach to the IEA workgroup on grid-connected storage, on the TC120 and on the ongoing discussions for the standardization of redox-flow battery storage system.

2.4.2 *Large inverters*

JRA 2.2 specifically focused on large-scale inverters with the following objectives.

- Development of requirements for the test environment for large-scale RES inverters
- Development of a blueprint for the realisation of a testing environment and infrastructure for large-scale inverters within the DERri consortium. The aim is to effectively use the available infrastructure of the project consortium and integrate it to provide a flexible environment for the full-scale testing of large-scale RES inverters.
- Research on and development of testing procedures for testing large-scale RES inverters: Experiences with test procedures currently applied in the laboratories of the consortium, Identification of gaps in current procedures, proposals for new or amended procedures for testing specific characteristics of the inverters.

The goal of JRA2.2 was to improve and expand the DERrI offer towards large RES inverters. keeping pace with the market developments. By using existing test and research facilities available at the partner laboratories, which do complement e.g. in terms of power ratings, energy sources, etc., the main objective of the work was to develop new testing procedures and provide best practises and guidance.

JRA2.2 addressed two complementary issues, namely the test environment requirements and secondly the associated test procedures for full-scale testing of RES inverters, taking into account their innovative functionalities.

The work in JRA 2.2 was organised in 3 complementary subtasks, starting with the investigation and the development of requirements for the test environment for large-scale RES inverters, followed by an implementation phase, aiming at an optimum use of available infrastructure. The final work focused on testing procedures for large-scale RES inverters, which were developed in the third subtask.

As initial step a comprehensive inventory of testing and research facilities for large-scale inverters available within the DERri consortium was made. Based on the experiences of the partners, requirements for the test environment for large-scale RES inverters were elaborated in order to specify the needs for large-scale RES testing. Particularly the following questions were answered:

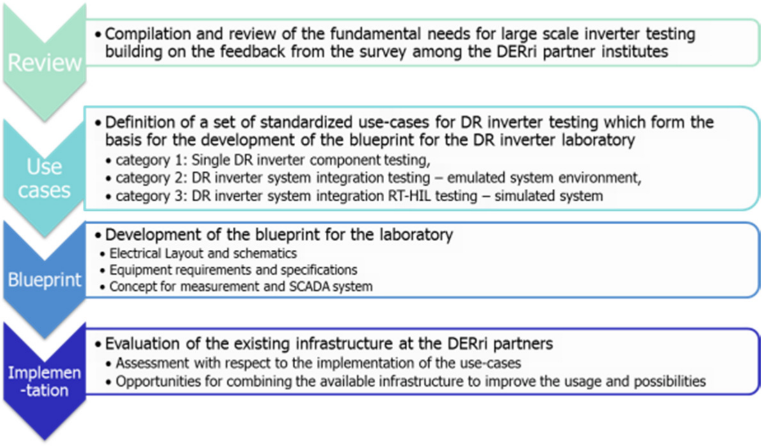
- how to adequately construct the primary power side (e.g. wind, PV etc.)?
- how to adequately emulate the actual network where the RES inverter is to be connected and especially the local conditions e.g. disturbances?
- how to match laboratory tests to field tests in order to ensure applicability of the test results?

The specified requirements provided the basis for the implementation of a test environment which allows researchers to perform full scale testing of RES inverters under a simulated system environment. This includes not only the flexible simulation of the distribution network, but also the RES generation. Furthermore, the inverter under test is integrated into a control and communication environment, which will allow testing the device behaviour under different simulated active network control schemes (e.g. Micro grids, distributed control, etc.).

In addition to the technical requirements, a concept of “standardised use-cases” was developed, which address the key testing and research cases and describe associated test environments and specifications.

Building on the experience of the DERri partner institutes which are already actively working with large-scale DR inverters and the fundamental requirements, a blueprint for the realisation of a research and testing facility for large-scale DR inverters (and its associated costs) based on the market development and business opportunities was developed. The aim was to effectively use the available infrastructure of the project consortium and integrate it to provide a flexible environment for the full-scale testing of large-scale RES inverters.

The objective of the blueprint laboratory environment is to meet the demand of industry (inverter manufacturers, system integrators, project developers…) as well as research for full-scale testing and investigations on large-scale inverters under an emulated system environment. Features addressed by the testing infrastructure include not only the power conversion stage but rather the complete device in a system environment. This concerns control and communication functions (active network control schemes such as micro grids, distributed control, etc.), protective components and functionalities, as well as performance and reliability.



Approach and methodology used for the development of the blueprint for the large-scale DR inverter test facility

In addition to the technical developments a cost analysis has been made based on the real cost of existing facilities to address also the financial aspect of developing and implementing the test infrastructure, including funding opportunities to support the setup as well as the integration of existing facilities. Different opportunities for implementing the environment were developed. The first option, the realisation as a whole at one of the DERri partners, allows researchers to perform comprehensive full scale research and testing at one single place. Alternatively, several DERri partners could link their existing facilities and jointly provide the features.

Building on the blueprint of the laboratory environment, testing procedures needed to adequately test large-scale RES inverters have been developed. The work builds on the experience of the DERri partner institutes which are already actively working with large-scale DR inverters and the standardised use case scenarios developed in the previous stage of the work. The goal was to harmonise the portfolio for testing of large-scale inverters which is available with the consortium, identify possible gaps and describe ways to fill these gaps.

Features addressed by the testing guidelines include not only standardised component tests but also tests related to the performance of the complete device in the system, e.g. regarding their interoperability in a Smart Grid control scheme. Therefore, tests also include concerns control and communication functions (active network control schemes such as Micro grids, distributed control, etc.), protective components and functionalities, as well as performance and reliability.

In addition to the testing guidelines, also test setups which are currently applied by the DERri partners are being investigated. Commonalities and differences are being identified and based on the feedback from the partners, ways to develop the infrastructure and testing services currently available within the consortium into a common large-scale inverter testing services portfolio are developed.

By this, the ultimate goal of the work in this task was to strengthen the position of the DERri partners working in the field of large-scale inverters and meeting the demand of industry (inverter manufacturers, system integrators, project developers…).

The key results reflect the three stage approach followed by the work in JRA 2.2. In the initial step a comprehensive inventory of testing and research facilities for large-scale inverters available within the DERri consortium was made, the survey includes detailed information on the laboratories and the available infrastructure and equipment such as (footprint, general setup, intended use…)

- AC sources: availability and capabilities (voltage, frequency, power level, programmability…)
- DC sources: availability and capabilities (voltage, power level, programmability…)

- Additional test equipment (e.g. RLC loads, line impedance networks, etc.)
- Test equipment for emulation of defined ambient conditions
- Test equipment for the emulation of communication links

At the end of the project, three members of the DERri consortium, AIT Austrian Institute of Technology, Fraunhofer IWES Systec (Germany) and KEMA FPGL (the Netherlands) are operating laboratory facilities for DER inverters in the power range of 100 kW to >1 MW (see table below).

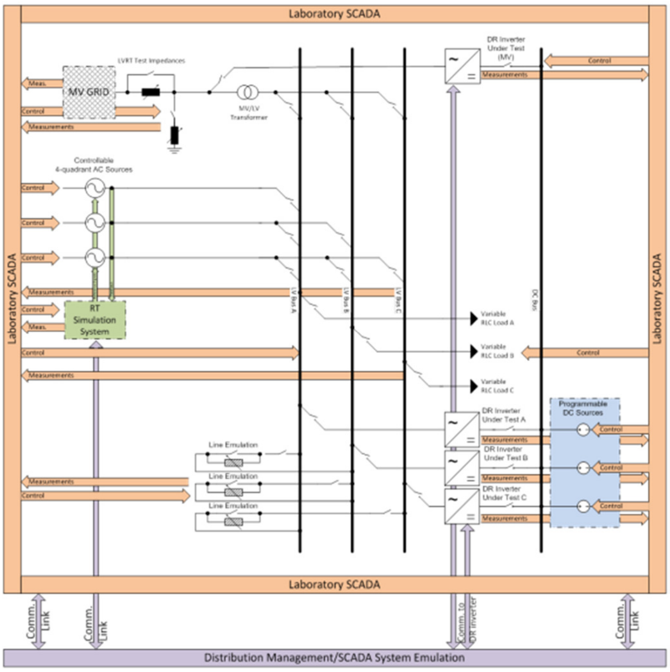
AIT	SmartEST Laboratory Power range: LV: up to 1 MVA; Voltage range 200 to 480 V (LV); Environmental test capability	
IWES	Systec Power range: LV: 1.25 MW, MV: 6 MVA; Voltage range of 100 V – 900 V (LV); 20 kV (MV)	
DNV KEMA	Flex Power Grid Laboratory Power range: up to 1 MVA; Voltage range: Three-phase: 400V-24kV, Single-Phase: 230V-50kV	

Dedicated laboratory facilities for large-scale DR inverters available in the DERri consortium

In addition to the inventory an extensive survey on needs and key requirements for the successful implementation of a large scale RES inverter laboratory was made. From the survey, a whole set of requirements, including, general functionalities and capabilities, AC and DC source related functionalities and capabilities, additional testing equipment for large-scale DR inverters, and safety related requirements was established.

Based on the long-term experiences with testing and evaluation of DR inverters, a number of key use-cases have been identified, represent the basic and most important use-cases for the design of the DR inverter test facility. The use-cases have been categorised based on their relevance for the fundamental laboratory layout into single DR inverter component testing, (Multiple) DR inverter system integration testing and DR inverter RT-HIL Testing.

Based on the use-case concept and corresponding test setups, a blueprint for a laboratory concept has been developed which allows to realization of all use-cases and the tests in an efficient and flexible manner. The blueprint concept can act as a basis for the development of new laboratory infrastructure as well as the adaptation of existing facilities for tests of DR inverters.



Blueprint concept for large-scale DR inverter laboratory

The facilities already available at the DERri partners are evaluated and assessed in relation to the possible implementation of the concept in the existing infrastructure. This evaluation and assessment with respect to the standardized use-cases concerns a number of aspects such as the laboratory setup, available equipment, design power & voltage levels as well as additional features. Last but not least, opportunities for combining the available infrastructure to improve the usage and possibilities are elaborated.

To get an overview of the current testing capabilities for large-scale inverters within the DERRI consortium, a survey based review of currently used procedures for tests and measurement of different features and characteristics of large-scale DR inverters was made. Within the survey some key facts, which need to be addressed for the future development of the individual laboratories as well as the overall portfolio within the consortium were highlighted.

To further increase the knowledge, identify common challenges and solutions case studies were made, addressing different aspects of DR inverter testing, including the grid related features as well as the PV and system performance related tests.

The 5 case studies prepared by the partners addressed the following aspects of large scale DR inverter testing and also present the capabilities and specific features of the individual laboratories:

- Static and dynamic MPPT performance testing of a large scale PV inverter (AIT SmartEST laboratory)
- Testing of grid features and interaction of large scale PV inverters (DNV KEMA FPGL)
- Testing of storage inverters (DNV KEMA FPGL)
- Testing the extended control functions of a large-scale PV inverter (Fraunhofer IWES SysTec laboratory)
- Testing LVRT/FRT at MV vs. LV level (Fraunhofer IWES SysTec laboratory)

Overall, the case studies showed that there are numerous common challenges the laboratories are facing as well as common practices being implemented to resolve certain issues.

Based on the experiences, and taking into account the results from the survey on testing procedures comprehensive guidelines for testing of large-scale DR inverters were elaborated, following the use case categories concept. Nevertheless, there are still gaps that have been identified in this analysis and need to be addressed in future work and standardisation.

Overall, the results of the joint work in JRA 2.2 will significantly strengthen the position of the DERri partners working in the field of large-scale inverters and meeting the demand of industry.

The work performed in JRA 2.2 and the results delivers a broad impact to different stakeholders. For the partners of JRA 2.2 partners as well as the whole DERri consortium, the following potential impact can be foreseen:

- The **comprehensive inventory** of DR inverter test facilities and available equipment within the consortium (AIT, IWES, DNV KEMA,…) creates the basis for the **implementation of joint tests** and joint use of laboratory infrastructure
- **Common understanding and harmonisation of testing procedures** for large-scale DR inverters and information exchange on critical issues for DR inverter testing supports the quality of tests and development of capabilities, including the **streamlined further development** and extension of the infrastructure.
- Last but not least, the **expansion of the testing portfolio** towards large RES inverters supports the position of the DERri consortium, keeping pace with the market developments.

From a wider perspective, the following impact can be foreseen for the EU and European stakeholders, including European industry:

- **Best Practise guidelines** for testing of large-scale DR inverters can be used as **input to EU standardisation**
- Powerful test infrastructure can help to strengthen European DR inverter manufacturers and reduce time-to-market for new products
- Joint experience based on the collaborative work within JRA 2.2 enables **EU test infrastructures** organised within DERlab to **extend their leading role in global networks**

2.5 REAL TIME SIMULATION ENVIRONMENT AND PARAMETER IDENTIFICATION FOR POWER SYSTEMS

Main Author: Thomas Strasser (AIT – JRA3 Work Package Leader)

The electrical energy supply system is called to satisfy a continuously growing demand for electricity. At the same time the society is obliged to decouple energy generation from the emission of greenhouse gases (especially of CO_2). This is only possible, if Renewable Energy Sources (RES) are being massively integrated. A large amount of RES is already locally available in a decentralised way or their roll-out is under development. Another challenge for electrical networks is the predicted increase in the integration of electrically driven vehicles into the electrical networks. The combined capacity of the batteries of these vehicles could have a significant capability for distributed energy storage. However, the production behaviour of RES and the consumption behaviour of electric vehicles are both showing stochastic characteristics. In order to develop, test and implement such Distributed Energy Resources (DER) appropriate methods, procedures and guidelines are necessary.

This issue could be solved by numerical real time simulation of the active network parts in a simulator together with the coupling of the simulated parameter (e.g., voltage or current) with the component under trial in a so-called Hardware-in-the-Loop (HIL) setup. The development, implementation and execution of such experiments in the laboratory context is still up to now a highly challenging activity. The development of proper methods and rules is a necessity, which was the main driving force for the work in JRA3.

The overall objective of the JRA3 work package was to define a comprehensive hardware and software simulation environment for power systems, distributed generators, protection and control equipment which are going to play a major role in the change towards more active networks (i.e., Smart Grids). Examinations with a powerful power system simulation environment including an interface to a hardware power system and components shall be applicable to more complex problem areas, and on the other hand the simulation results shall reveal more precise predictions for future applications.

The main focus of this JRA therefore was to combine the expertise as well as the laboratory infrastructure available in the project consortium by the DERri partners to establish a specialised test facility for HIL simulation of power systems and components. The test facility allows grid operators to gain comprehensive answers on system questions in regard to safety functions, grid management, security of supply and quality of supply. Plant supplier and operators profit from more precise component behaviour descriptions and better support of component developments.

Summarizing, the main objectives for JRA3 have been:

- Definition of a comprehensive hardware & software simulation environment for power systems with focus on DER components
- Specialized test facility for real time HIL simulation of power systems and (DER) components
- Test facility will allow Distribution Network Operators (DNO) to perform investigations in the field of protection, grid management and quality of supply
- Effectively integrate and use the existing Research Infrastructure (RI) at the partner's sites

In order to achieve the challenging aims and objectives of this JRA the following three main activities/phases have been carried out in the context of the JRA3 work package:

- **Requirements phase**

  During the first phase requirements on power systems and device simulation with a focus on real time and HIL capable approaches has been performed. Therefore an overview and identification of existing tools used by the project partners for offline steady state and dynamic (transient) simulation as well as for real time simulation was carried out. Moreover existing models for energy generation, conversation and storage technology, as well as for compensators and distribution grids have been identified and analysed.
  In addition a collection and analysis of requirements and uses cases for offline and real time simulation has been made. About 40 use cases have been collected in a first step by the DERri JRA3 members and in a second step about 80 requirements have been derived out of it. The use cases as well as the requirements have been analysed and categorized according to DER device types and simulation objectives.

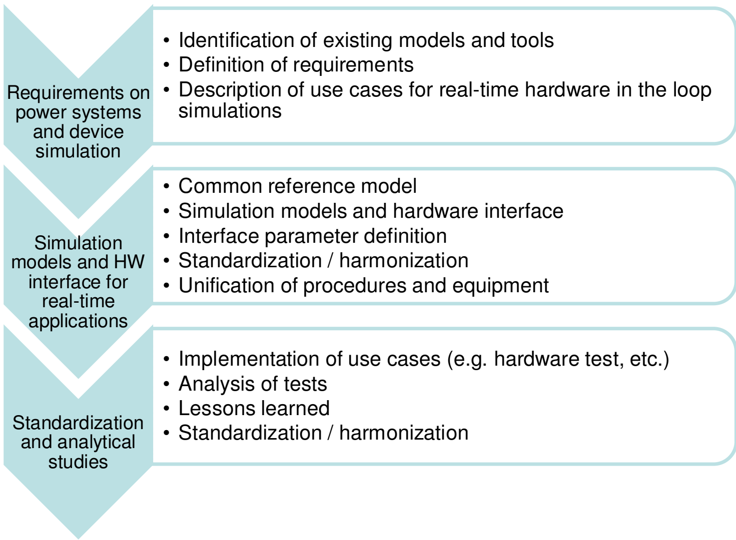
- **Real-time/HIL simulation environment definition**

  In the second phase of the implementation of the JRA3 work a so-called Common Reference Model (CRM) for DER components has been defined in order to facilitate the exchange of existing component models but also to have a common procedure to define new models. During analysis phase of existing models and tools it turned out that an exchange of models between the partners is not always be an easy task since different model representations, languages and simulators are in use. With the availability of the CRM specification and corresponding modelling rules a harmonization of DER models have been achieved.
  Another important activity during this 2nd phase of JRA3 was on the definition of HIL testing and validation possibilities for DER components. Therefore, the so-called Power Hardware-in-the-Loop (PHIL) approach has been implemented or has been extended at some of the laboratories. A major work was on the further development of the hardware and software interfaces of the PHIL approach and the collection of the applied testing procedures used by the JRA3 partners.

- **Harmonization, standardization and analytical studies**

  In the final phase the CRM specification has been validated by comparing reference implementations of selected DER component in different simulators but also with results from PHIL and pure laboratory experiments.
  A further activity was also to harmonize the different PHIL testing procedures used by the DERri JRA3 partners in order to have a better repeatability and comparability of the performed test cases and experiments. Also lessons learned have been collected and analysed to further develop the PHIL testing approach for DER components.
  Finally, some proposals have been collected which can be used as basis for further standardization activities for CRM-based modelling, real-time simulation and HIL experiments.

A brief summary of the most important S&T activities performed in the framework of the JRA3 work package is shown in the following figure.



Main JRA3 S&T activities and applied working methods

The main S&T results obtained in JRA3 can be summarized as follows:

- Collection of use cases and requirements

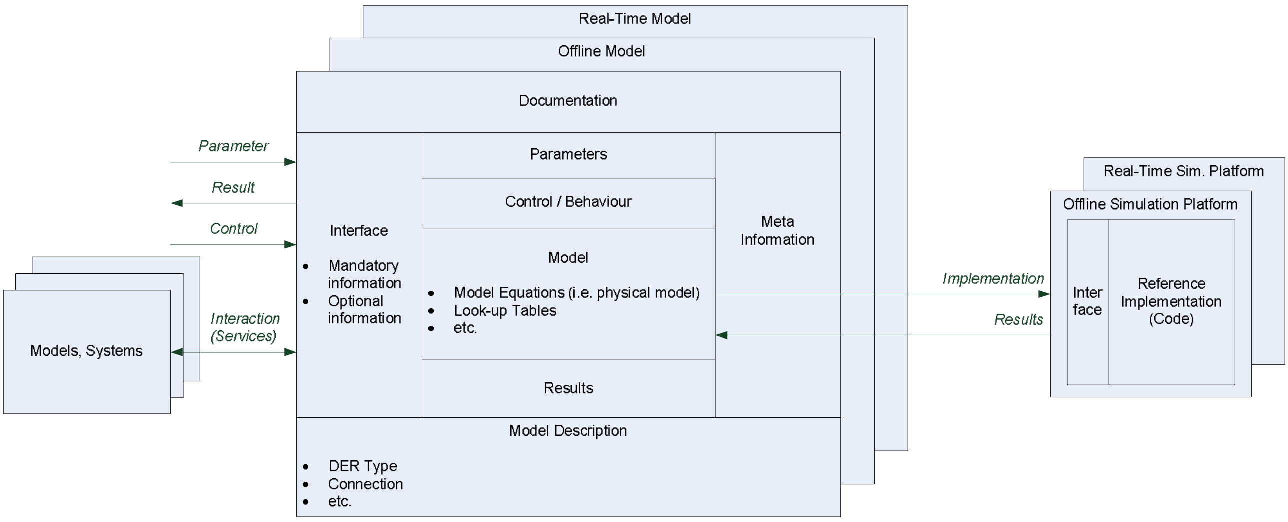
  A collection of use cases and the derivation of requirements for power systems and device simulation with focus on real-time simulation and Hardware-in-the-Loop (HIL) experiments have been made. The goal of the identification and collection of use cases and requirements was the ensuring that all interested individuals and organizations involved in whole JRA3 have the same understanding of the use cases and requirements related to advanced validation and testing methods based on simulation. The collected use cases and requirements served later on as basis for the definition and specification of a Common Reference Model (CRM) for DER components and simulation types/objectives as well as also for the development of enhanced simulation testing methods. The following methodology has been used:
    - Categorization of DER devices and simulation types
    - Collection of use cases
    - Categorization of use cases
    - Derivation and categorization of requirements

  About 40 use cases have been collected during in a first step by the DERri JRA3 members and in a second step about 80 requirements have been derived. The use cases as well as the requirements have been analysed and categorized.

- Common Reference Model (CRM) for DER devices

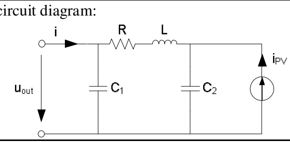
  A CRM has been defined by the DERri partners, which allows a simpler exchange of model data between the partners and other research groups. The CRM should improve the portability and exchangeability of DER device models for different simulation experiments, especially for real time simulations. Therefore, multiple simulation models can be associated to the CRM for a specific DER in order to cover the different usage of it. The CRM should also define an interface description, which can be used for its different instances (e.g., for offline, real-time simulation experiments). In addition, an

important role in this context is the HIL approach[1] where a real-time simulation of DER devices and other grid components with small time steps (typically in the range of a few µs for PHIL up to ms for CHIL) is necessary. In order to be able to simulate DER device models in this time frame often a reduced real-time representation with sufficient accuracy compared to offline models is necessary. Moreover, the CRM representation should also contain measurement results of DER devices in order to validate/compare them with the physical/mathematical model and to calculate its accuracy.
An overview of the resulting CRM definition is provided in **Errore. L'origine riferimento non è stata trovata.**



Overview of the Common Reference Model for DER Devices.

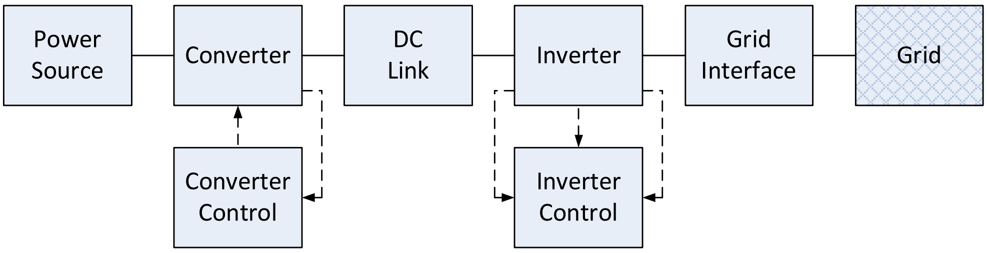
The following figure shows the usage of the CRM specification for a PV-Inverter model.

CRM Model Element	PV-Inverter
Representation / Symbol	Input → YINV → Output
Interface	Input: i Output: u_{out}
Parameters	i_{pv}, R, L, C_1, C_2
Control / Behaviour	---
Model	Equivalent circuit diagram: 
Results	---
Model Description	Simplified model of the PV-inverter which implements only the output filter; this model can be used for PHIL offline simulation in order to validate the stability of the PHIL experiment before performing the whole experiment.
Meta Information	• Author: DERri consortium • Institution: AIT, EDF, NTUA, USTRAT, RSE • Date: May 2011 • Version: 1.0 • Reference implementation: Matlab/Simulink Model
Documentation	Implements a simple PV-inverter model (i.e. only the output filter of the PV-inverter with current source)

Example for the usage of the CRM specification.

[1] Including Power-Hardware-in-the-Loop (PHIL) and Controller-Hardware-in-the-Loop (CHIL).

In addition, a generic modelling scheme for inverter-based DER devices was developed to obtain modular components for different simulation objectives which is depicted in the following figure.



Proposed generic block scheme for simulation model of DERs interfaced to the grid with inverters

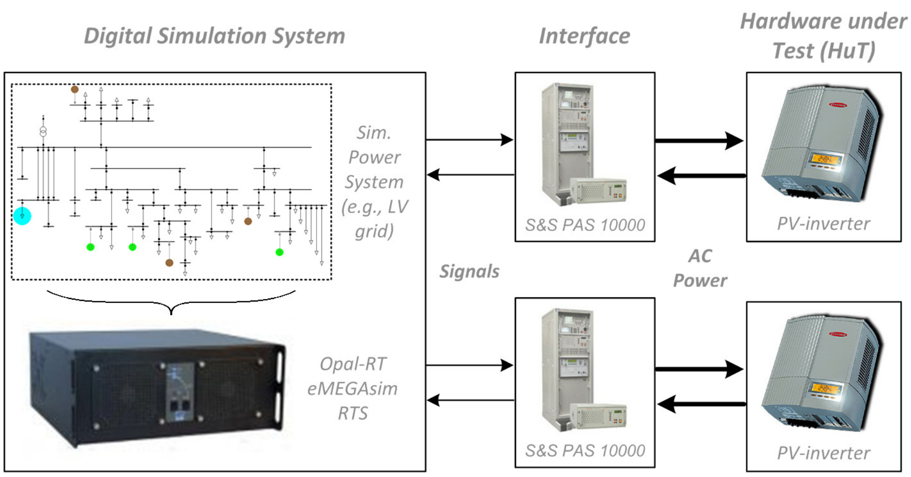
This would improve and fasten the modelling of the DER devices and therefore the whole simulation and HIL procedure.

- Tools and methodologies to perform dynamic, real time simulations and HIL experiments

A further major result of JRA3 was related to the identification and characterisation of hardware interfaces, which are a very important parameter for HIL experiments, especially for PHIL simulations. In addition, interfaces for CHIL have also been investigated. Moreover, the main types of HIL simulations, CHIL and PHIL experiments were analysed theoretically and through laboratory experience. A literature review was performed which provides a comprehensive overview of both simulation types, highlights the key issues, advantages and challenges of the HIL method which can be considered as the future of testing and validation in the power and energy domain.

Several DERri partners have installed and are operating laboratories with PHIL functionality using the following main devices as depicted in the following figure:

- Powerful Real-Time Simulation system
- Power Interface (i.e., power amplifier)
- Measurement and control devices



Typical PHIL setup

The available hardware and software equipment used by the JRA3 partners' as well as laboratory test/use cases related to real time simulation and HIL experiments have been collected reported to provide an overview which equipment is available and can be used for certain use/test cases and experiments.

The harmonization of applied rules and procedures for executing PHIL was also a major result of JRA3 Also lessons learned and potential improvements of this advanced testing and validation method has been provided by the DERri partners. Therefore, an analysis of the available PHIL equipment, corresponding test cases and experiences/lessons learned showed that the following challenges are crucial and have to be taken into account when a PHIL experiment is carried out:

- Clear added value of the performed PHIL experiment
- Stability of the whole PHIL setup
- Accuracy of the achieved PHIL simulation results
- Usage of a proper Real-Time Simulator (RTS), Power Interface (PI), Interface Algorithm (IA) and measurement equipment for the performed experiment
- Safe execution of the PHIL experiment

Taking the above points into account the following main testing steps are suggested by DERri JRA3 performing a PHIL experiment (i.e., basic laboratory procedures):

1. Evaluation of the added value of the PHIL experiment
2. Preparation of the PHIL experiment
    - Generation of the offline simulation model of the PHIL experiment (i.e., simulated power systems and corresponding components)
    - Implementation of the used interface algorithm
    - Stability evaluation using formal stability evaluation methods (e.g., Nyquist criterion) and/or pure software simulation
    - Evaluation of achievable accuracy
    - Generation of the real-time capable simulation model
    - Implementation of safety/protection mechanisms (in hardware and/or software)
    - Test of the real-time model in the RTS without connected PI and HuT
3. Execution of the experiment
    - Preparation of the laboratory equipment (i.e., RTS, PI and measurement equipment)
        - Configuration/parameterization of RTS, PI and measurement device(s)
        - Connecting RTS with PI, HuT and measurement device(s)
        - PI startup
    - Optional: Simulated open loop test
    - Execution of the experiment (i.e., closing the loop)
4. Analysis of the achieved results

The following list provides a brief overview of the potential impact of the JRA3 results:

- The comprehensive collection of different use cases and requirements for real time simulation and HIL experiments can be further used in projects and activities by the DERri partners and therefore provide a good starting point.

- The CRM specification provides a modelling scheme and guidelines, which allows an easier exchange of DER models between the DERri partners in following activities but also for other potential users in international projects.
- The HIL-based test possibilities available at several DERri partners provide extended testing and validation possibilities for DER components but also for integration and system studies under more realistic conditions compared to pure numerical software simulations. Component manufacturers and vendors as well as DNOs can profit from the availability of these research infrastructure with extended possibilities and services.
- The developed PHIL test procedures and guidelines provide a very good basis for the implementation of PHIL experiments at the DERri partner's laboratories. They allow also a better repeatability and comparability of the achieved results between the partners.
- There is a high potential that the CRM specification for the DER model exchange as well as the defined procedures and testing rules for HIL-based experiments are being used in standardization activities and therefore becoming available for a broad range of activities to potential users outside of the DERri consortium.

2.6 DISSEMINATION

Main Author: Sini Numminem (DERlab – Work Package Leader)

Objectives of the Work Package NA4 Information and dissemination were to

- ensure maximum awareness among all potential applicants about the transnational access opportunity offered and to
- ensure maximum and wide spreading of the new knowledge gained within the project.

A wide-spreading visibility for the project, and for the TNA opportunity in particular, could only be reached by and efficient utilisation of the existing contact networks and communication channels of all project partners. Some partners have extensive industrial contact lists and the others can reach, for example, hundreds of researchers in universities in their home country or at international level. Emails and telephone calls were not the only methods utilised. Partners also presented the DERri TNA opportunity as well as DERri results in suitable forums in their institutions, such as during business meetings or in university lectures. This approach was very effective, and also qualified since the partners' knowledge of partners on local contexts could be utilised for the benefit of DERri project's dissemination purposes.

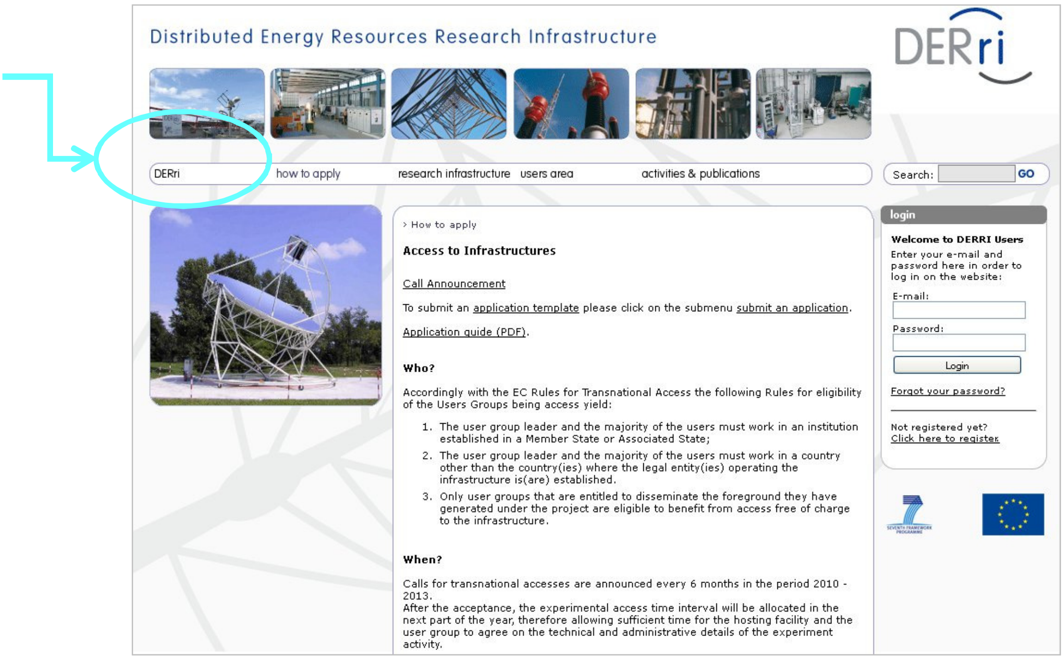
Three months prior to each TNA call deadline, a strong dissemination campaign was coordinated by DERlab. The dissemination material that was made available for the partners was published on a specific section on the project website, consisting of the letter template, presentation template, TNA call announcement poster and the flyer. Along with disseminating the email newsletter for their contact lists, the partners also utilised other methods, such as company websites and social media for giving visibility for the call.

As many as 15 000 copies of DERri flyers and another bunch of DERri TNA posters were disseminated around the technical universities in Europe and handed out for research partners in international events

Each partner reported on their planned and performed dissemination activities for the WP leader. DERlab kept track on these activities, including external events where partners had presented DERri or otherwise ensured its visibility. The dissemination activities were discussed during regular telephone conferences and meetings, this allowing the partners to share information, ideas, experiences and best practices.

By maintaining such an overview of the activities, including a list of different stakeholders contacted, the consortium could also identify gaps in the target groups reached. Such a group could be, for example, technical universities and SMEs in the field of Distributed Energy Resources in a country that is not represented in the project consortium. Responsibilities for reaching such groups were agreed with the NA4 partners.

An important factor in the dissemination coordination was the persistent follow-up of preliminarily positive responses by either the partner who had the original contact with the applicant, or with the project coordinator.



DERri website contains all relevant information regarding the TNA procedures

In addition to promoting the laboratory access, the project partners also ensured the dissemination of information on the JRA activities and project results as such. In addition to the number of scientific publications, JRA activities results were presented also in a set of fact sheets that are available for download on the DERri website. Regular reporting on these activities resulted in deliverables D_NA-4.6 - D_NA-4.9 Journal articles and conference presentations – Collections 1-4.

In Annex 2 the following material is gathered:

- Some examples of dissemination tools and initiatives
- List of some major dissemination initiatives
- List Dissemination publication/intiatives/ etc. of DERri Results
- Dissemination initiatives led by the Users of the DERri Transnational Access.

3 IMPACT & CONCLUSIONS

At the beginning of the DERri project, the consorted laboratories had three high-level objectives, against which the impact of the project must be measured.

- **Infrastructure Objective**

The first objective was the Infrastructure Objective. The goal was to open the access of research teams to a unique Research Infrastructure, formed by the integration of excellent laboratories and organizations, spread all over Europe, sharing their know-how in the same research field (i.e. the Smart Grid and the DER integration) and structured as a coordinated Network. To this extent DERri aimed at creating the conditions and the tools to integrate, coordinate and manage the potential of the cooperating laboratories. The expected impact from this approach covers a variety of operating characteristics:

- integration and deployment of the complementary capacities of the laboratories, simultaneously exploiting the potential of each facility;
- creation of synergies at all levels among the laboratories, by sharing reciprocal know-how; acceleration of the cross-fertilization of the ideas through more useful communication; agreement of operational rules; the sharing and mastering of good practices; creation of a common understanding and development of new methods and procedures;
- improvement of the overall quality of the offered services;
- reduction in the need and urgency of investment in the facilities.

- **Technical Objective**

The second objective was of a technical nature. The goal was to improve the technical capacity of each laboratory, and of the DERri Research Infrastructure as a whole, with regard to the research and experimentation with DER technologies, and their integration in the Grid. This has been achieved through first identifying the synergies and complementarities within the research infrastructures and then the definition, development and validation of testing methods, either brand new methods or by further development of previous methods within the laboratories and the Research Infrastructure as a whole. The expected impact from this strategy is:

- creation of validated experiments for the testing of DER devices;
- creation of reliable laboratory based experiments for the testing of DER devices within complex systems, as an alternative to real field trials, that are often impractical and expensive;
- harmonising laboratory tests to make them repeatable and reproducible, due to the sharing of methods and results, and also the benchmarking of a number of test cases;
- improvement of the experimental test by making them more useful and efficient through the cooperation of the laboratories, and the sharing of validated best practices;
- making recommendations for standardization on testing;
- enhancing the transparency of the procurement of technologies and products as an effect of the standardization of the testing methods.

- **Market Objective**

The third objective related to the Service Provider nature of the DERri laboratories. This is mainly relevant to those laboratories operating in a commercial field, but also has some bearing on those working in the research sector. The goal of this objective was to improve the portfolio of the capabilities offer to users (Research and Industry teams) and increase their access.

The main strategy to attain this objective was the creation of methods, procedures and tools for attracting users and providing services at an enhanced quality, with higher efficiency and reduced cost. The achievement of this objective has enhanced the capacity of the laboratories to:

- facilitate the access of users;
- make more efficient the process tied to the testing;
- clearly define and publicise the actual portfolio of the laboratories and of the DERri Research Infrastructures as a whole (what they are really able to do);
- improve this portfolio of capabilities;
- coordinate access to the laboratories in relation to user needs and the laboratories' capacity;
- assess the critical paths of the process and the level of satisfaction of the users;
- define common procedures and agree Quality Standards ensuring the reciprocal acknowledgement of the expertise and, in perspective, the mutual accreditation of the laboratories.

The activities developed in DERri under the EC formula I3 (JRA, NA and TA) actually combined to achieve the above objectives and to realise, in the short to medium timespan, the expected impact.

The Joint Research Activities

- provided tools allowing the interconnection and the interoperability among the laboratories;
- developed validated technical procedures for tests on components and systems;
- proposed new testing methods;
- defined the blueprint of new testing installations, based on existing capacity and the complementarities of the laboratories.

The Networking Activities, through:

- agreement on reference Quality Standards;
- the execution of proficiency (round robin tests) involving six laboratories operating to the same use case;
- the shared definition of a Services portfolio and the mapping of the laboratories on to this portfolio;
- the set-up of online access tools, procedures and protocols of stay (including safety issues).

The Transnational Access activities, allowing:

- the access of new Users to the Research Infrastructures;
- the creation of new Use Cases and the implementation of the relevant test procedures;
- a more complete knowledge of technical gaps and requirements;
- an increased understanding of the incidence of the access and operating costs of the installations. This aspect was not so clear especially to non-commercial laboratories.

Amongst others, the following highlights are especially worth highlighting for their major impact on the general and specific objectives of DERri, and for their impact on EU Smart Grid developments:

- **The development, set-up and validation of the JaNDER concept**

A real time capable laboratory interface for connection of remote test facilities is now available, validated through selected experiments. The interconnection via the JaNDER gateway allows for a better utilization of specialized research infrastructures and for long-term tests. The interconnection of the testing facilities via the DERri JaNDER gateway is paving the way to a virtual laboratory (or e-infrastructure) allowing for a better utilization of specialized research infrastructures and facilitating long-term tests or field trials.

Additionally, the use of the JaNDER gateway is not restricted to inter-laboratory communication but can also be applied to field trials for remote and long-term monitoring of devices.

- **Use of CIM and IEC protocols for the virtualization of labs**

The virtual representation of facilities via CIM and IEC protocols opens up the possibility to increasing the exploitation of capacity of each laboratory. The DERri deliverable D_JRA-1.6 should be leveraged by IEC TC57 WG13, which is in charge of maintaining the IEC 61968-13 profile (Common Distribution Power System Model), for which a 3rd edition should be released in the coming months. It should be noted that the DERri Transnational Access GSSSI-EDU project directly supported these results.

- **The development of testing methods and procedures for performance and life-cycle testing of grid-connected energy storage systems (ESS)**

Other the impact within the consortium, this result will benefit ESS manufacturers and ESS operators in order to characterize and compare ESS with each other, thus enhancing the industry's competitiveness. Developed ESS indicators should also assist ESS operators to improve their storage system operation in real-time and also for maintenance purposes. The approach will be discussed in the IEA workgroup on grid-connected storage, in IEC-TC120 and during the on-going discussions for the standardization of redox-flow battery storage systems.

- **Blueprint of a facility for tests on large inverters and testing procedures**

Best Practise guidelines for testing of large-scale DR inverters can be used as an input to EU standardisation of DR inverter testing. Powerful test infrastructure can help to strengthen European DR inverter manufacturers and reduce the time-to-market for new products.

The corresponding DERri Deliverables (D_JRA-2.2.2 and D_JRA-2.2.3) were recognised as valuable potential contributions to the IEA Implementing Agreement within the initiatives of ISGAN- SIRFN. For this reason, under specific request from SIRFN, D_JRA-2.2.2 was converted from Confidential to Public deliverable.

- **Development of Power-Hardware-In the-Loop real time environment testing method**

The developed PHIL test procedures and guidelines provide a good basis for the implementation of PHIL experiments at the DERri partner's laboratories. They also allow an increased repeatability and better comparability of the achieved results between the partners.

The HIL-based test capacity available at several DERri partners provide extended testing and validation possibilities for DER components; and further provide opportunities for integration and system studies under more realistic conditions compared to pure numerical software simulations. Component manufacturers and vendors, as well as DNOs, can benefit from the availability of those research infrastructures with extended possibilities and services.

The CRM specification for the DER model exchange, as well as the defined procedures and testing rules for HIL-based experiments, constitute a DERri contribution to the work of the IEEE Task Force on “Real-Time Simulation of Power and Energy systems”. The Common Reference Models of DER components are under consideration for CIM and IEC 61850 standardisation.

In conclusion, the following table maps the achievements of DERri against its declared objectives.

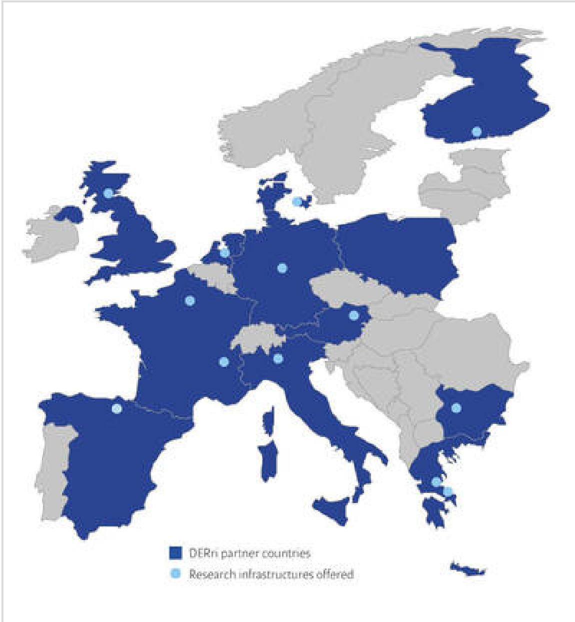
HIGHLIGHTS FROM DERri / DERri OBJECTIVES AND IMPACT		JRA1		JRA2			JRA3	NA2			TA			
		Jander concept development	CIM and IEC protocols implementation	Testing methods and procedures on storage systems	Testing methods and procedures on large invetrers	Blueprint of a facility for Large Inverters	CRM and procedures for PHIL tests	Internal Workshops	Labs Data Base	Common Standards for Quality Management	Agreed procedures for access and reporting	Assessment of criticalities	Test cases implementation	Dissemination & Web Portal
Infrastructure objective	Exploiting at the best the potential of each lab		■	■	■	■	■			■			■	
	Integrating and deploying complementary capacities	■	■			■	■							
	Creating synergies at all levels	■								■				
	Improving the overall quality of the offered services	■		■	■		■			■		■		
Technical Objective	Developing New Methods, Procedures and tools for tests on DER components and complex systems			■	■	■	■							
	Sharing know-how							■		■		■	■	■
	Improving the usefulness of the testing process	■	■											
	Improving reliability of the tests making them repeatable and reproducible			■	■		■			■				
	Recommending Standardization of methods and procedures			■	■		■							
	Improve operation, maintenance and Procurement			■	■		■							
Organization/Market Objective	Facilitating the access of the Users								■		■			■
	Making the process more efficient	■		■	■		■				■	■		■
	Clearly defining and showing the actual portfolio of the labs and of the Research Infrastructure								■					■
	Improving the portfolio	■		■	■	■	■							
	Coordinating the access in relation to the User needs and the labs capacity								■		■			
	Assessing the criticalities of the process and the level of satisfaction of the Users											■	■	
	Defining common procedures and agreeing Quality Standards ensuring the reciprocal acknowledgment									■		■		

ANNEX 1: List of the DERri Beneficiaries and Contact persons

Nr	Name	Short name	Country	ROLE in DERri	Contact Person	e-mail address
1	Ricerca sul Sistema Energetico - RSE S.p.A. (co-ordinator)	RSE	IT	Coordinator	Giorgio Franchioni	giorgio.franchioni@rse-web.it
2	Austrian Institute of Technology GmbH	AIT	AT	NA2 WP Leader	Christoph Mayr	christoph.mayr@ait.ac.at
				JRA2.2 WP Leader	Roland Bründlinger	roland.bruendlinger@ait.ac.at
				JRA3 WP Leader	Thomas Strasser	thomas.strasser@ait.ac.at
3	Commissariat à l´Energie Atomique et aux énergies alternatives	CEA	FR	JRA2 WP Leader	Nicolas Martin	nicolas.martin2@cea.fr
4	Centre for Renewable Energy Sources	CRES	EL		Evangelos Rikos	vrikos@cres.gr
5	Électricité de France S.A.	EDF-SA	FR		Eric Lambert	eric.lambert@edf.fr
6	Fraunhofer-Institut für Windenergie und Energiesystemtechnik	Fraunhofer-IWES	DE	NA3 & JRA1 WP Leader	Wolfram Heckmann	Wolfram.Heckmann@iwes.fraunhofer.de
7	KEMA Nederland B. V.	KEMA	NL		Erik de Jong	erik.dejong@kema.com
8	Fundación TECNALIA Research & Innovation	TECNALIA-LAB	ES		Josè Emilio Rodriguez	jemilio.rodriguez@tecnalia.com
9	Institute of Communication and Computer Systems	ICCS-NTUA	EL		Panos Kotsampopoulos	kotsa@power.ece.ntua.gr
10	Danmarks Tekniske Universitet	RISOE-DTU	DK		Per Norgaard	pern@risoe.dtu.dk
11	Politechnika Lodzka	TU Lodz	PL		Pawel Kelm	pawel.kelm@p.lodz.pl

Nr	Name	Short name	Country	ROLE in DERri	Contact Person	e-mail address
12	Technical University of Sofia	TUS-RDS	BG		Anastassia Krusteva	krusteva@tu-sofia.bg
13	Teknologian Tutkimuskeskus VTT	VTT	FI		Kari Mäki	kari.maki@vtt.fi
14	University of Strathclyde	USTRAT	UK		Paul Crolla	p.crolla@strath.ac.uk
15	The University of Manchester	UNIMAN	UK		Joseph Mutale	j.mutale@manchester.ac.uk
16	European Distributed Energy Resources Laboratories (DERlab) e. V.	DERlab-A	DE	NA4 WP Leader	Sini Numminen	sini.numminen@der-lab.net

ANNEX 2 – Examples of dissemination tools and initiatives



DERri graphic material: logo and the project partner map

Distributed Energy Resources Research Infrastructure (DERri)

Press release

Distributed Energy Resources Research Infrastructure (DERri)
Coordinator: Dr. Paolo Mora, Ricerca sul Sistema Energetico - RSE S.p.A.
Via Rubattino, 54
20134 Milano, Italy
Tel: +39 02 3992 4223
e-mail: info@der-ri.net
www.der-ri.net

DERri Network grants Free Access to Research Infrastructure for Scientists

Milan, 11 April 2012. The Distributed Energy Resources Research Infrastructure (DERri) is calling scientists from industry and research organisations to apply for the free access to the laboratories. The selected user teams will have the chance to access and use the research facilities, including all laboratory installations within the DERri Network, for experiments free of charge. All expenses, including travel and accommodation are reimbursable, under the conditions agreed with the hosting institutions. The next application deadline is 30 June 2012.

DERri is a collaborative research project under the 7th Framework Programme (FP7) of the European Commission, gathering 16 partners from 12 countries distributed all over Europe. The project partners have unique and complementary DER research infrastructures and leading DER expertise. Since 2010 more than 20 research projects have already been conducted in earlier instalments of this research programme.

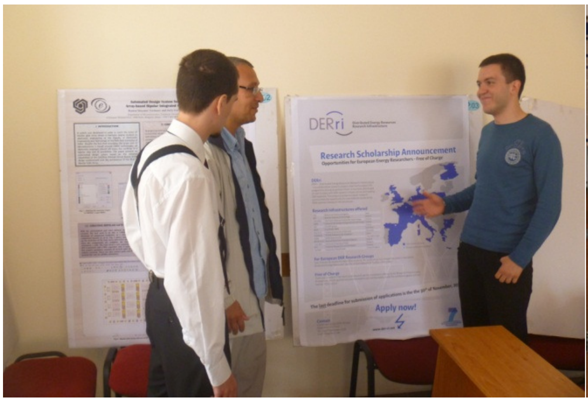
Eligible Applicants

For researchers to apply for a free access there are three conditions. The applying researchers have to work for organisations that are established in countries of the European Union or associated European states like Switzerland, Turkey or Israel. Secondly, the research team, or its majority, must work in countries other than where the operator of the infrastructure is established. Lastly, researchers must have the permission to publicly report about their project. The starting time and length of the projects are flexible.

The research programme continuously supports DER research. The next dates for this year are 30 June and 30 November. Applications will be accepted as long as the laboratories have capacity available.

Press release advertising the DERri Transnational Access was sent in April, 2012 for 800 specialized journalists and editors throughout Europe

DERri



DERri project gained visibility in tens of conferences in Europe, such as in the ELECTRONICS conference in Sozopol (BG) in 2012, presented by TUS (picture on the left) and in the final dissemination event in Milan (IT), 2013 (picture on the right and Flyer below).

The DERri Project

DERri is a EU collaborative research project under the FP7 research programme. It aims at the enhancement and the effective deployment of experimental infrastructures in support of the research on the Distributed Energy Resources integration in the EU energy system. As many as 16 European Institutions from 12 different countries have been cooperating in the project during four years, from Sept 2009 to Dec 2013. They include excellent Research Infrastructures with leading DER expertise and equipped with unique testing facilities.

Joint research and networking within a single cooperation infrastructure of facilities having advanced expertise in the same field and first order equipment brings several advantages to the potential and the quality of the offered service: effective development and sharing of testing methods and procedures; better deployment of technology; fruitful exchange and dissemination of information; synergies and complementarities exploitation.

The Transnational Access to the infrastructures by EU research teams responding to periodical access calls launched by DERri is a further qualifying aspect of the project, allowing to value in practice the cooperation framework among the laboratories; to identify and share pros and gaps of the offered service; to disseminate the laboratories potential in the research and industry fields and to contribute to the development of innovative solutions proposed by the users.

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For information on this Event:
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Consortium

Ricerca sul Sistema Energetico - RSE www.rse-web.it
Austrian Institute of Technology (AIT) www.ait.ac.at
The French National Institute for Solar Energy www.ines-solaire.org
Centre for Renewable Energy Sources and Saving (CRES) www.cres.gr
The EDF group www.edf.com
Fraunhofer IWES www.iwes.fraunhofer.de
Technical University of Denmark www.risoe.dtu.dk
TECNALIA Research & Innovation www.tecnalia.com
DNV KEMA www.dnvkema.com
National Technical University of Athens (ICCS-NTUA) www.ntua.gr
Technical University of Lodz www.weeia.p.lodz.pl
Technical University of Sofia www.tu-sofia.bg
VTT Technical Research Centre of Finland www.vtt.fi
University of Strathclyde www.strath.ac.uk
University of Manchester www.eee.manchester.ac.uk
European Distributed Energy Resources Laboratories (DERlab) www.der-lab.net

DERri
Distributed Energy Resources Research Infrastructure

Conference:
Experimental research and DER integration in the EU Energy System

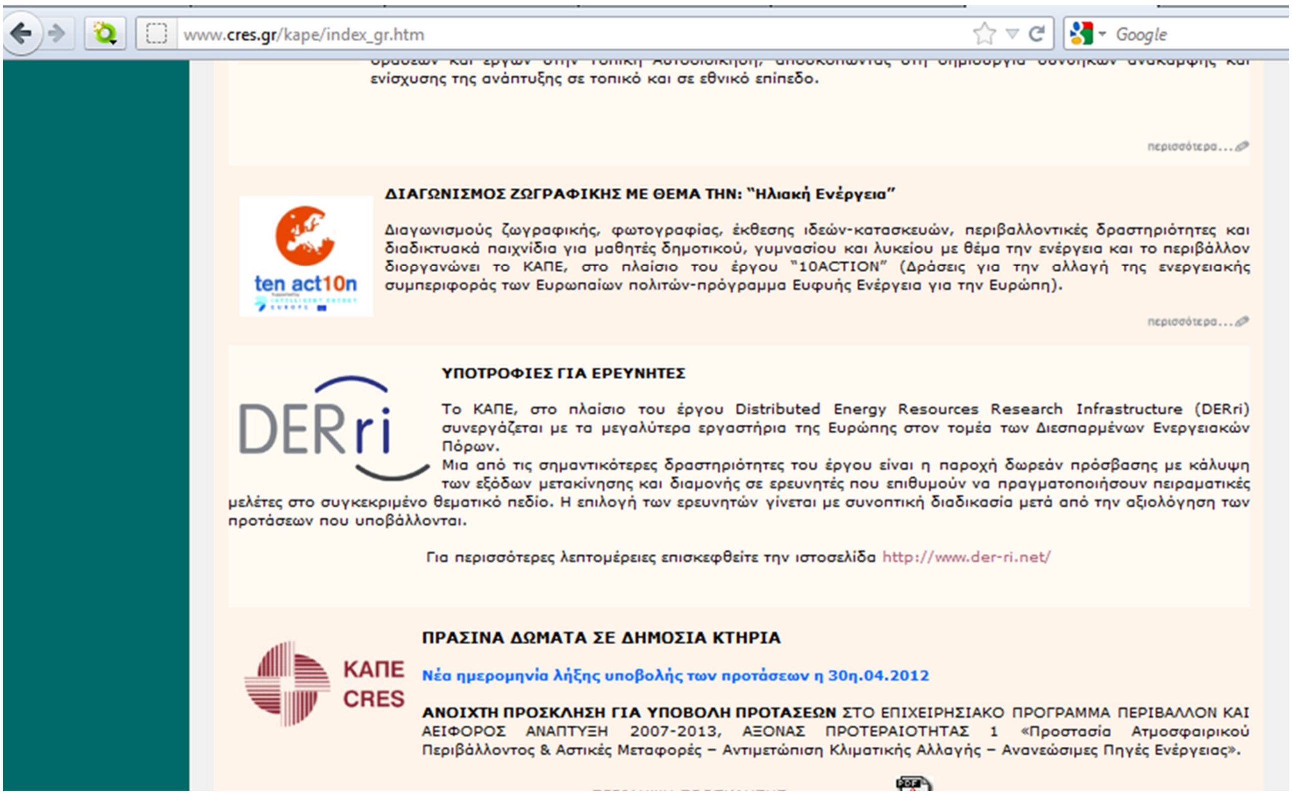
in connection with
the Dissemination meeting:
Results, Highlights and Prospects of the EC FP7 project DERri

10 and 11 October, 2013
RSE premises, Milan, Italy

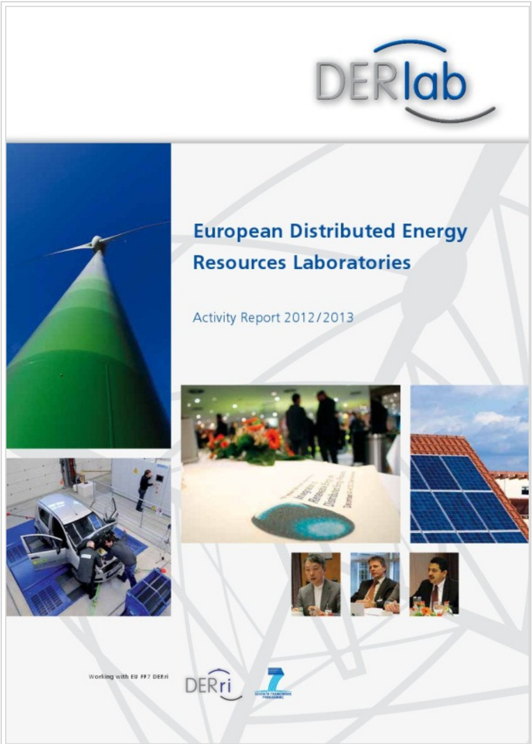
www.der-ri.net

SEVENTH FRAMEWORK PROGRAMME

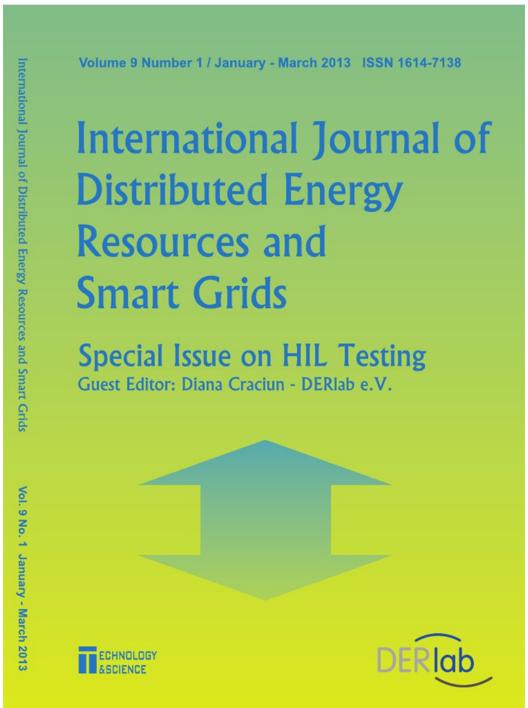
DERri partners promoted DERri using various dissemination channels, such as with a Twitter note by TECNALIA in 2012 (in English and Spanish) or in a company newsletter "e-bulleting" by CEA-INES in 2012 (in French)



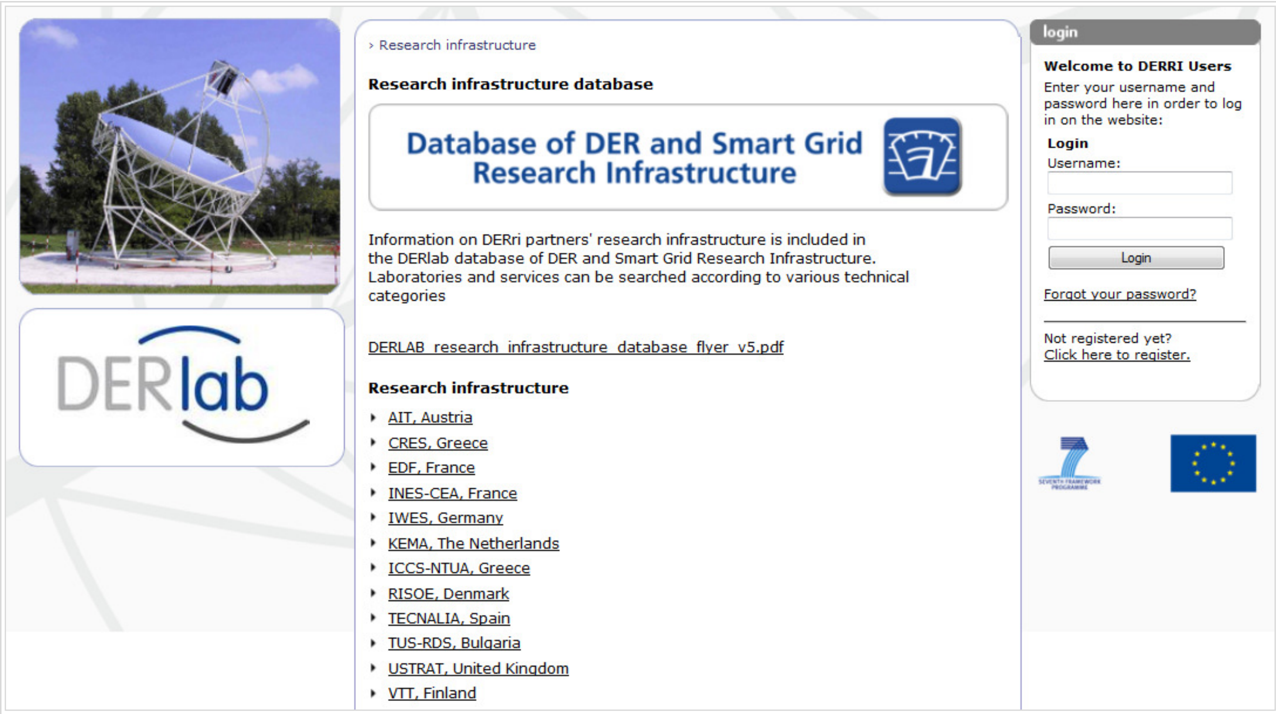
DERri partners published the TNA call also on their websites. In the image a screenshot of the website of CRES (in Greek)



DERri was visible also on the annual reports of the project partners. DERlab activity report 2012/2013 was published in April 2013.



Several DERri partners sent their contribution to the DERlab special issue on Hardware-in-the-loop Testing of the "International Journal of Distributed Energy Resources and Smart Grids" (Vol 9 Number 1 2013). This publication can be considered as an important result summarising the joint research activities of the DERri partners.



Facility information of TNA partner laboratories was included also in the DERlab database of DER and Smart Grid Research Infrastructure which will be maintained by DERlab association and DERlab members after the end of DERri project.

3.1 LIST OF SOME MAJOR DISSEMINATION INITIATIVES

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
1	Poster presentation	RSE	A European Distributed Energy Resources Laboratory: the DERri Infrastructure	12/2010	4th International Conference on Integration of Renewable and Distributed Energy Resources, Albuquerque (US)	Research, industry, decision-makers	Hundreds	International
2	Sending DERri TNA call newsletters for contact lists and DERri website registered users	DERlab, NA4 partners	Scholarship announcement for DER research experiments. Apply until DD MM	Periodically before TNA calls during 2011-2013	Kassel (DE)	Scientists, industry, European technical universities	Thousands	Europe
3	Publishing DERri TNA call or general DERri	DERlab, CRES,	Looking for a laboratory	Periodically before TNA	Various	Various	Thousands	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
	information on the institute websites or other company publications and via email announcements	TECNALIA, CEA, VTT, IWES, TULodz, RSE, TUS-RDS, ICCS-NTUA	facility for your research experiments? Deadline for DERri TNA applications is DD MM	calls during 2011-2013				
4	Disseminating flyers, posters and holding general presentations including DERri activities and DERri research infrastructures	DERlab, AIT, RSE, CRES, ICCS-NTUA, TUS-RDS, TECNALIA, CEA, EDF, VTT	-	Frequently 7/2011-10/2013	During research project meetings and for business contacts	Scientists and industry	Hundreds	Europe
5	Dissemination of flyers during scientific conferences	AIT, CRES, TUS-RDS, ICCS/NTUA, RSE, CEA, DERlab,	Distributed Energy Resources Research Infrastructure	Frequently during 11/2011-10/2013	PVSEC, CIRED, IRES, IEEE IES IECON, Energy Forum, ELECTRONICS,	Research, industry, decision-makers	Thousands	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
		IWES, TECNALIA, VTT	(DERri)		IRED, Kasseler Symposium, SGEM events			
6	Presentation and a paper	AIT (E. Mrakotsky, C. Mayr, M. Stifter, T. Strasser)	Sharing Laboratory Infrastructures for Integrating more Energy from Renewable Sources to the Grid - The FP7 project DERri - Distributed Energy Resources Research Infrastructure	10/2011	Presentation at the Envirolinfo 2011 conference, JRA, Ispra (IT) and a paper in the Conference proceedings "Innovations in Sharing Environmental Observations and Information", ISPRA, JRC, 2011. ISBN: 978-3-8440-0451-9; S. 300 - 308.	Research, industry	Thousands	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
7	Presentation including the DERri laboratory access procedure and the available research infrastructure	DERlab		January, 2012	APEC-ISGAN Smart Grid Test Bed Networks workshop, Washington (US)	Scientists, regulators, national ministry representatives, industrial representatives	100	International (Europe, Japan, Australia, US, China, Korea)
8	Disseminating flyers and holding a presentation including DERri activities and DERri research infrastructures	DERlab	-	February 2012	Steering committee meeting of EERA JP Smart Grids, Kassel (DE)	Researchers in the field of DER and Smart Grids	40	Europe
9	Sending a press release	DERlab (coord)	DERri Network grants Free Access to Research Infrastructure for Scientists	April, 2012	Milan (IT)	Specialized press	800	Europe
10	General DERri	CEA	Distributed Energy	April, 2012	IEA Energy Conservation	Research	10	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
	presentation		Resources Research Infrastructure (DERri)		with Energy Storage Annex 26" meeting			
11	Dissemination of flyers	ICCS-NTUA	Distributed Energy Resources Research Infrastructure (DERri)	04/2012	5th Conference of Electrical and Computer Engineering Students of Greece, Xanthi (EL)	Engineering students	300	Greece
12	Describing DERri project at the DERlab Activity Report 2011/2012	DERlab	DERlab in European Community projects	September, 2012	DERlab Activity Report 2011/2012, Kassel (DE)	Scientists, regulators, industrial representatives in the field of DER and Smart Grids	8000	International
13	Disseminating DERri flyers	DERlab		October 2012	Steering Committee meeting of ETP	Mainly industry	20	Europe

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
					Smart Grids, Brussels (BE)			
14	Dissemination of two DERri posters, general DERri flyers and the DER Journal Special issues for all conference participants	DERlab	-	December, 2012	5th International Conference on Integration of Renewable and Distributed Energy Resources (IRED), Berlin (DE)	Scientists, regulators, national ministry representatives, industrial representatives	300	International (Europe, Japan, Australia, US, China, Korea)
15	Poster presentation	AIT, ICCS-NTUA, USTRAT, RSE, DERlab	Harmonising hardware-in-the-loop simulation procedures for power systems and distributed energy resources	December, 2012	International Conference on Integration of Renewable and Distributed Energy Resources (IRED), Berlin (DE)	Scientists, regulators, national ministry representatives, industrial representatives	300	International (Europe, Japan, Australia, US, China, Korea)

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
			components					
16	Poster presentation	DERlab, RSE	The EU DERri Project: open use of Research Infrastructures for experimental activities in the field of integration of Distributed Energy Resources	December, 2012	International Conference on Integration of Renewable and Distributed Energy Resources (IRED), Berlin (DE)	Scientists, regulators, national ministry representatives, industrial representatives	300	International (Europe, Japan, Australia, US, China, Korea)
17	Dissemination article on DERri TNA outcome at the DERlab Activity Report 2012/2013	DERlab, RSE, TNA partners	Supporting European Access to Research and Testing Facilities	April, 2013	DERlab Activity Report 2012/2013, Kassel (DE)	Scientists, regulators, industrial representatives in the field of DER and Smart Grids	10000	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
18	Dissemination article on DERri JRA3 outcome at the DERlab Activity Report 2012/2013	AIT, ICCS-NTUA, DERlab	Harmonising Hardware-in-the-Loop Simulation Procedures	April, 2013	DERlab Activity Report 2012/2013, Kassel (DE)	Scientists, regulators, industrial representatives in the field of DER and Smart Grids	10000	International
19	Dissemination article on DERri JRA1 outcome at the DERlab Activity Report 2012/2013	DERlab, IWES	Virtual Demonstration Laboratory for Remote Testing and Control	April, 2013	DERlab Activity Report 2012/2013, Kassel (DE)	Scientists, regulators, industrial representatives in the field of DER and Smart Grids	10000	International
20	Conference: Experimental research and DER integration in the EU Energy System	RSE	Various	October, 2013	DERri final event, Milan (IT)	Scientists and industrial representatives in the field of DER and Smart Grids; regulators	70	International

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date/Period	Place	Type of audience	Size of audience	Countries addressed
21	Presentations on the results of DERri	all partners	Various	October, 2013	DERri final event, Milan (IT)	Scientists and industrial representatives in the field of DER and Smart Grids; regulators	70	International

3.2 DISSEMINATION OF DERRI RESULTS

Publications

[1] A. Viehweider, G. Lauss, F. Lehfuss, "Stabilization of Power Hardware-in-the-Loop simulations of electric energy systems", Simulation Modelling Practice and Theory, 19 (2011), 7, p.1699 - 1708.

[2] A. Viehweider, G. Lauss, F. Lehfuss, "Verbesserung der Genauigkeit und Stabilitätseigenschaften von Power Hardware-in-the-Loop Simulationen mittels einer Dual-Rate-Schnittstelle", e & i Elektrotechnik und Informationstechnik, 4 (2011), 4, p. 128 - 134.

[3] G. Lauss, F. Lehfuss, A. Viehweider, "Power Hardware-in-the-Loop Simulations for Distributed Generation", CIRED 2011, Germany, 2011.

[4] F. Lehfuss, G. Lauss, "Implementing a Multiple Input Multiple Output Power-Hardware-in-the-Loop Experiment with Photovoltaic Inverters as Hardware under Test", Real time 2011 - OPAL RT User conference, Shanghai, China, 20.06.2011 - 22.06.2011, in: "Real time 2011 presentations", (2011).

[5] E. Mrakotsky, C. Mayr, M. Stifter, and T. Strasser, "Sharing Laboratory Infrastructures for Integrating more Energy from Renewable Sources to the Grid: The FP7 project DERri — Distributed Energy Resources Research Infrastructure", Innovations in Sharing Environmental Observation and Information (EnviroInfo 2011), October 5-7, Ispra, Italy, 2011.

[6] G. Lauss, F. Lehfuss, A. Vieweider, and T. Strasser, "Power Hardware in the Loop Simulation with Feedback Current Filtering for Electric Systems", in appears in 37th Annual Conference of the IEEE Industrial Electronics Society (IECON'2011), November 7-10, Melbourne, Australia, 2011.

[7] F. Andrén, S. Henein, M. Stifter, "Development and Validation of a Coordinated Voltage Controller using Real-time Simulation", in appears in 37th Annual Conference of the IEEE Industrial Electronics Society (IECON'2011), November 7-10, Melbourne, Australia, 2011.

[8] K. Mäki, M. Hashmi, J. Farin, M-L. Pykälä, "Modelling and Experimental Verification of Converter Drive System for Distributed Generation", IET Renewable Power Generation Conference 2011, Edinburgh, UK, 2011.

[9] T. Strasser, F. Lehfuß, P. Kotsampopoulos, P. Crolla, C. Tornelli, S. Numminen: Harmonising hardware-in-the-loop simulation procedures for power systems and Distributed energy resources components. Abstract submitted to IRED 2012, Berlin, Germany, December 04-06, 2012.

[10]R. Brandl, T. Degner, D. Geibel, A. Seibel: Active & Smart Substations: Development and Testing of Intelligent Control Strategies for LV-Networks with High Share of DER. Abstract submitted to IRED 2012, Berlin, Germany, December 04-06, 2012.

[11]P. Kotsampopoulos, V. Kleftakis, G. Messinis, N. Hatziargyriou: Design, development and operation of a PHIL environment for Distributed Energy Resources. Presentation at the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON'2012), Montreal, Canada, October 25-28, 2012.

[12]P. Kotsampopoulos: Laboratory Experiences With Power-hardware-in-the-loop Simulation for Distributed Energy Resources. Presentation at the IEEE PES Innovative Smart Grid Technologies (ISGT) conference, Berlin, October 17, 2012.

[13]T. Strasser, M Stifter, W. Hribernik, E. Lambert, P. Kotsampopoulos, P. Crolla, C. Tornelli: Improving the Portability and Exchangeability of Model Data for Smart Grids focusing on Real-Time Simulations – Definition of a Common Reference Model. CIGRE Session 44 Paris, France, August 2012.

[14]F. Lehfuss, G. Lauss, P. Kotsampopoulos, N. Hatziargyriou, P. Crolla, A. Roscoe: Comparison of multiple Power Amplification types for Power Hardware-in-the-Loop Applications. IEEE Workshop on Complexity in Engineering (COMPENG 2012), Aachen, Germany, June 11-13, 2012.
[15]B. Kleftakis, P. Kotsampopoulos: PHIL simulation and voltage increase due to the Photovoltaic production in Low Voltage grids. 5th conference of electrical and computer engineering students of Greece, Xanthi, Greece, April 2012.
[16]T. Strasser, F. Lehfuss, P. Kotsampopoulos, P. Crolla, C. Tornelli, S. Numminen: Harmonising hardware-in-the-loop simulation procedures for power systems and distributed energy resource components. Proceedings of 5th International Conference on Integration of Renewable and Distributed Energy Resources, Berlin, Germany, December 4-6, 2012.
[17]E.C.W. de Jong, P.T.M. Vaessen, R.A.A. de Graaff: The role of Hardware in the loop in validation and testing. International Journal of Distributed Energy Resources and Smart Grids - Special issue on Hardware-in-the-loop Testing, Volume 8, number 4, pp. 5 et sqq., October - December 2012
[18]P. Kotsampopoulos, A. Kapetanaki, G. Messinis, V. Kleftakis, N. Hatziargyriou: A PHIL facility for microgrids. International Journal of Distributed Energy Resources and Smart Grids, vol. 9, no. 1, pp. 71-86, January-March 2013.
[19]F. Andrén, F. Lehfuss, and T. Strasser: A Development and Validation Environment for Real-Time Controller-Hardware-in-the-Loop Experiments in Smart Grids. International Journal of Distributed Energy Resources, vol. 9, no. 1, pp. 27-50, January-March 2013.
[20]G. Lauss, B. Bletterie, C. Mayr, F. Lehfuss, R. Bründlinger: Power-Hardware-in-the-Loop Simulations for Electrical Generators in LV Grids. International Journal of Distributed Energy Resources and Smart Grids, vol. 9, no. 1, pp. 51-71, January-March 2013.
[21]T. Strasser, M. Stifter, W. Hribernik, E. Lambert, P. Kotsampopoulos, P. Crolla, C. Tornelli: Improving the Portability and Exchangeability of Model Data for Smart Grids Real-Time Simulations – Definition of a Common Reference Model. e&i Elektrotechnik und Informationstechnik, pp. 1–6, 2013.
[22]N. Hatziargyriou, P. Kotsampopoulos, V. Kleftakis, A. Vassilakis, A. Rigas: DER supporting the grid simulations by means of Power-Hardware-in-the-Loop. In proceeding of: 2013 IEEE PES General Meeting, Volume: GM2471 presentation in Panel "Control of Converter Interfaced DER Connected at Distribution Networks"
[23]P. MacDougall, P. Crolla, G. Burt, P. Heskes, C. Warmer: Fast demand response in support of the active distribution network. Proceedings of 22nd International Conference and Exhibition on Electricity Distribution (CIRED), Stockholm, Sweden, June 10-13, 2013.
[24]A. Tomova, M. Antchev, M. Petkova, H. Antchev: Fuzzy logic hysteresis control of a single-phase on-grid inverter: computer investigation. International Journal of Power Electronics and Drive System (IJPEDS), Vol. 3, No. 2, June 2013.
[25]M. Petkova, M. Antchev, A. Tomova: Computer Investigation and Verification of the Operation of a Single-Phase On-grid Inverter with Hysteresis-Current Control. Proceedings of EuroCon 2013, Zagreb, Croatia, July 1-4, 2013.
[26]R. Stanev, A. Krusteva, C. Tornelli, C. Sandroni: A Quasi-Dynamic Approach for Slow Dynamics Time Domain Analysis of Electrical Networks with Distributed Energy Ressources. Accepted for conference presentation. 5th Scientific Conference of Electrotechnical Faculty of TUS, Sozopol, Bulgaria, September 2-3, 2013.
[27]R. Stanev, M. Raykov: Mathematical modelling of Battery Storage Systems for Quasy Dynamic Analysis of Hybrid Micro Grids. Conference presentation. 5th Scientific Conference of Electrotechnical Faculty of TUS, Sozopol, Bulgaria, September 2-3, 2013.

[28]R. Stanev: Voltage control strategies for distribution networks with distributes energy resources. Conference presentation. 5th Scientific Conference of Electrotechnical Faculty of TUS, Sozopol, Bulgaria, September 2-3, 2013.
[29]V. Kleftakis, A. Rigas, A. Vassilakis, P. Kotsampopoulos, N. Hatziargyriou: Power- Hardware-in-the-loop simulation of a D-STATCOM equipped MV network interfaced to an actual PV inverter. Accepted for presentation at the IEEE 4th European Innovative Smart Grid Technologies (ISGT) Conference, Copenhagen, Denmark, October 2013.
[30]B.-I. Craciun, T. Kerekes. D. Sera, R. Teodorescu, R. Brandl, T. Degner, D. Geibel, H. Hernandez: Grid Integration of PV Power based on PHIL testing using different Interface Algorithms. 39th Annual Conference of the IEEE Industrial Electronics Society (IECON'13), Special Session "Real-time Simulation and Hardware-in-the-Loop Validation Methods for Power and Energy Systems". Vienna, Austria, November 10-13, 2013. (Result of the TA project "SPVSYS".)
[31]K. Mentesidi, M. Santamaria, M. Aguado, A. Vassilakis, A. Rigas, V. Kleftakis, P. Kotsampopoulos: Power Hardware-In-The- Loop technique applied to a LV Network for integrating a Supercapacitor with an Average Model of STATCOM. Accepted for presentation at the IEEE International Workshop on Intelligent Energy Systems IWIES 2013, Vienna, Austria, November 2013. (Result of the TA project "DEIAgrid".)
[32]G.T. Costanzo, L. Ferrarini, G. Mantovani, A. Krusteva, M. Georgiev, M. Antchev: A hardware-in-the-loop simulation architecture for integration of Smart Buildings and distributed energy resources in Micro Grids. Accepted for publication. Journal of Information technologies and control.
[33]M. Antchev, I. Pandiev, M.Petkova, E.Stoimenov, A.Tomova, H.Antchev: PLL for Single Phase Grid Connected Inverters. Accepted for publication. IEEE Transactions on Industrial Electronics.
[34]F. Andrén, F. Lehfuss, P. Jonke, T. Strasser, E. Rikos, P. Kotsampopoulos, P. Moutis, F. Belloni, C. Sandroni. C. Tornelli, A. Villa, A. Krusteva, and R. Stanev, "DERri Common Reference Model for Distributed Energy Resources – Modelling Scheme, Reference Implementations and Validation of Results," extended abstract accepted for CIGRE Session 2014, SC C6 Distribution Systems and Dispersed Generation, PS1 > Design of distribution networks with high penetration of DER and new loads, August 24-29, Paris, France, 2014.
[35]R. Bründlinger, M. Müller, O. Arz, W. Miller, J. Schulu, G. Lauss: A Comprehensive Performance Analysis of State-of-the-Art MPPT Charge Controllers, 7th International Conference on PV-Hybrids and Mini-Grids, Oral Presentation, April 10-11, 2014, Bad Hersfeld, Germany.
[36]A.Prostejovsky, A. Dimeas, M. Merdan, G. Schitter, "Demonstration of a Multi-Agent-Based Control System for Active Electric Power Distribution Grids", IEEE International Workshop on Intelligent Energy Systems IWIES2013, November 2013, Vienna, Austria.
[37]R. Neves-Medeiros, A. Krusteva, St. Valtchev, G. Gigov, P. Avramov: Experimental study on induction heating equipment applied in wireless energy transfer for smart grids. Accepted for DoCEIT'14 , 7-9 April 2014, Caparica, Lisbon, Portugal (Results of the TA project "WOLEVET")
[38]K. Mentesidi, E. Rikos, V. Kleftakis, P. Kotsampopoulos, M. Santamaria, M. Aguado, "Implementation of a Microgrid model for DER Integration in Real-Time Simulation Platform", Submitted to the 23rd IEEE International Symposium on Industrial Electronics, June 2014, Istanbul, Turkey (under review).
[39]S. Skarvelis-Kazakos, E. Rikos, E. Kolentini, L.M. Cipcigan, N. Jenkins: Implementing agent-based emissions trading for controlling VirtualPower Plant emissions, Electric Power Systems Research, vol. 102, pp.107, March 2013.
[40]A. Parisio, E. Rikos, L. Glielmo: A Model Predictive Control Approach to Microgrid Operation Optimization. Paper submitted to IEEE Transaction on Control System Technology.
[41]A. Parisio, E. Rikos, G. Tzamalis, L. Glielmo: Use of Model Predictive Control for Experimental Microgrid Optimization. Paper submitted to Elsevier Applied Energy.

[42]T. Brown, N. Martensen, S. Cherevatskiy, E. Rikos: A multi-objective control strategy for distribution networks with renewables. Conference contribution submitted to CIRED Workshop 2014 "Challenges of Implementing Active Distribution Management Systems", June 11-12, 2014, Rome, Italy.
[43]International Journal of Distributed Energy Resources and Smart Grids, Volume 9 – ISSN 1614-7138 – Jan 2013 - http://www.der-journal.org/abstracts-2005-2010/volume-9-2013/number-1-january-march/index.html
[44]P. Kotsampopoulos, "Real-Time simulation and microgrids", DERlab's PhD and Young Researcher Seminar: Distributed and Renewable Generation, Glasgow, United Kingdom, April 2011
[45]E. de Jong, R. de Graaff, P. Vaessen, P. Crolla, A. Roscoe, F. Lehfuss, G. Lauss, P. Kotsampopoulos, F. Gafaro: "European White Book on Real-Time Power Hardware-in-the-loop testing", DERlab e.V., 2012

Special session

[1] T. Strasser, F. Lehfuss, P. Crolla, Organization of the Special Session "Real-time Simulation Methods for Smart Grids", at the 37th Annual Conference of the IEEE Industrial Electronics Society (IECON'11), Melbourne, Australia, 2011.
[2] T. Strasser, P. Crolla, O. Faruque, P. Kotsampopoulos, Organization of the Special Session "Real-time Simulation and Validation Methods for Power and Energy Systems", at the 38th Annual Conference of the IEEE Industrial Electronics Society (IECON'12), Montreal, Canada, 2012.
[3] G. Lauss, F. Lehfuss, F. Andrén, T. Strasser: Preparation of the special session "Real-time Simulation and Hardware-in-the-Loop Validation Methods for Power and Energy Systems". The 39th Annual Conference of the IEEE Industrial Electronics Society (IECON'13),Vienna, Austria, November 2013.

Activities/ Technical Committees:

[1] IEEE Power & Energy Society (PES) – Task Force on Real-Time Simulation Methods for Power and Energy Systems – AIT (G. Lauss, F. Lehfuß, T. Strasser), NTUA (P. Kotsampopoulos), USTRAT (P. Crolla)
[2] IEEE Industrial Electronics Society (IES) – Technical Committee on Smart Grids – AIT (M. Stifter, T. Strasser)

DERri

3.3 DISSEMINATION INITIATIVES LED BY THE USERS OF THE DERRI TRANSNATIONAL ACCESS

USER PROJECT	DISSEMINATION INITIATIVE
INVERTER	Carole Lainé, Urbain Lambert: “Inverter - From today’s challenge to tomorrow’s opportunities”; presented at 14th ABC (Asian Battery Conference) in Hyderabad; India on 14th of September 2011
CA-VPP	Spyros Skarvelis-Kazakos, Evangelos Rikos, Efstathia Kolentini, Liana M. Cipcigan, Nick Jenkins: “Implementing agent-based emissions trading for controlling VirtualPower Plant emissions” Electric Power Systems Research 102 (2013) 1– 7
	Spyros Skarvelis-Kazakos: “Emissions of Aggregated Micro-generators”Thesis submitted for the degree of Doctor of Philosophy - Cardiff 2011
DISCOSE	P. MacDougall, P. Crolla, G. Burt, P. Heskes, C. Warmer: “Fast demand response in support of the active distribution network”. Proceedings of 22nd International Conference and Exhibition on Electricity Distribution (CIRED), Stockholm, Sweden, June 10-13, 2013.
SOPC_Microgrids	A. Parisio, E. Rikos, G. Tzamalis, and L. Glielmo, "Use of Model Predictive Control for Experimental Microgrid Optimization", Elsevier Applied Energy 115 (2014) 37–46 http://www.sciencedirect.com/science/article/pii/S0306261913008477
EVOLVE-MAS	P. Papadopoulos, I. Grau, M. Fernández, J. Jimeno , E. Zabala, L.: “Analysis of an Electric Vehicle Agent Based Management Model” presented at the 3rd European Smart Grids and E-Mobility conference, Munich, Germany, 17th-18th October 2011, organised by OTTI. Presentation at the DERri Conference: “Experimental research and DER integration in the EU Energy System”, organized by DERri project, Milan October 10^{th} 2013
POLSAR	Massimo Antoniali, Andrea M. Tonello, Stephan Weiss, Graeme M. Burt: “ IEEEPower Line Communications on a Outdoor and Industrial Low Voltage Test Network” Submitted to IEEE Transactions on Smart Grids
	Paul Crolla, Andrea Tonello, Stephan Weiss and Graeme Burt: “Evaluation of Narrowband Power Line Communications on a Smart Grid Testbed” Paper presented for IEEE ISGT EU 2011 conference (10.1109/ISGTEurope.2011.6162791)
SEM-BAD	Giuseppe Tommaso Costanzo, Anna Magdalena, Guchuan Zhu, Luca Ferrarini, Miguel F. Anjos, Gilles Savard: “An Experimental Study on Load-Peak Shaving in Smart Homes by Means of Online Admission Control”
MSPC	A. Parisio, E. Rikos, and L. Glielmo, "A Model Predictive Control

USER PROJECT	DISSEMINATION INITIATIVE
	Approach to Microgrid Operation Optimization", IEEE Transaction on Control System Technology http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=6705582&queryText%3DA+Model+Predictive+Control+Approach+to+Microgrid+Operation+Optimization). A. Parisio, E. Rikos, G. Tzamalis, and L. Glielmo, "Use of Model Predictive Control for Experimental Microgrid Optimization", Elsevier Applied Energy 115 (2014) 37–46 http://www.sciencedirect.com/science/article/pii/S0306261913008477
RESSIC	F. Baccino, O. M. Forero Camacho, F. R. Isleifsson, M. Marinelli, P. B. Nørgård, F. Silvestro: “Experimental validation of control strategies for a microgrid test facility including a storage system and renewable generation sets”, CIRED Workshop, pp. 1-4, Lisbon, 29-30 May 2012 - Paper 251
	F. Baccino, M. Marinelli, S. Massucco and F. Silvestro: "Low Voltage Microgrid under Islanded Operation: Control Strategies and Experimental Tests", full paper submitted to IEEE MedPower 2012, pp. 1-7, Cagliari, Oct. 2012
	F. Baccino, M. Marinelli, S. Massucco and F. Silvestro: "Vanadium Redox Flow Battery Dynamic Modelling and Experimental Validation", Energy Storage, full chapter submitted, pp. 1-24, ISBN: 979-953-307-768-9, InTech Edition, expected publishing date Sep 2012
SPVSYS	Paper submitted to IECON 2013, the 39th Annual Conference of the IEEE Industrial Electronics Society, November 10-13, 2013, Vienna, Austria
SREI-MG	Giuseppe Tommaso Costanzo, Luca Ferrarini, Giancarlo Mantovani, Anastassia Krusteva, Georgiev Metody: “A hardware-in-the-loop simulation architecture for integration of Smart Buildings and distributed energy resources in Micro Grids” Published on the Journal of Information technologies and control, ISSN 1312-2622 http://www.acad.bg/rismim/itc/ L. Ferrarini and G. Mantovani, “Modeling, control and energy management of a large commercial building for energy efficiency improvement”, accepted for presentation at IEEE International Workshop on Intelligent Energy System, IWIES, Vienna, 14 Nov 2013.
MoDERN	Papadopoulos, Panagiotis and Papadopoulos, Theofilos and Papagiannis, Grigoris and Crolla, Paul andRoscoe, Andrew and Burt, Graeme (2013) *Modeling of distributed energy resources using laboratory-experimental results.* In: 48th Universities' Power Engineering Conference (UPEC 2013), 2013-09-02 - 2013-09-05, Dublin. *Dynamic performance of a low voltage microgrid with droop controlled distributed generation.* In: 2013 IEEE Power and Energy Society (PES)

USER PROJECT	DISSEMINATION INITIATIVE
	General Meeting, 2013-07-22 - 2013-07-25, Vancouver. *A Black-Box Dynamic Equivalent Model for Microgrids Using Measurement Data.* In: IET Generation, Transmission & Distribution. – journal – accepted Nov 2013 Panagiotis N. Papadopoulos, Theofilos A. Papadopoulos, Grigoris K.: "Dynamic Modeling of a MicroGrid using Smart Grid technologies"
EnergyMAD	Michail Calin: "PHIL for voltage assessment in unbalanced active grids", presented at 'Experimental research and needs in support of the DER integration in the EU Energy System" Workshop, October 2013, Milano, Italy Michail Calin: "Power electronics converter-based control strategies for active distribution grids" PhD. thesis
SPS-LPQDS	P. Balawender: ""Localization of the voltage dips sources in the power system" - Master Degree Thesis delivered at AGH University, July 2013 P. Balawender, K. Chmielowiec: ""Localization of the voltage dips sources in the power system" - To be presented at the International Conference on Electrical Power Quality and Utilisation, EPQU 2014 R. Koziel: ""Localization of the voltage fluctuations sources in the power system" - Master Degree Thesis delivered at AGH University, September 2013 R. Koziel, K. Chmielowiec: ""Localization of the voltage fluctuations sources in the power system" - To be presented at the International Conference on Electrical Power Quality and Utilisation, EPQU 2014 K. Chmielowiec: ""Technical condition for connections of electrical loads causing electromagnetic disturbances. Case studies" - PhD Thesis in progress, AGH University, December 2014
TESCABI	Roland Bründlinger, Michael Müller, Ortwin Arz, Joachim Schulz, Georg Lauss: "Was leisten MPP-Tracking Laderegler? Eine umfassende Performanceevaluierung im Labor" 28. Symposium Photovoltaische SolarenergieBad Staffelstein, March 6-8 2013
	Roland Bründlinger, Michael Müller, Ortwin Arz, Werner Miller, Joachim Schulz, Georg Lauss: "A comprehensive performance analysis of state-of-the-art MPPT charge controllers" Oral presentation at the 7th International Conference on PV-Hybrids and Mini-Grids, April 10th - 11th, 2014 - Stadthalle Bad Hersfeld, Germany
	M. Müller, O. Arz, W. Miller, R. Bründlinger, J. Schulz, G. Lauss: " PV-off-grid hybrid systems and MPPT charge controllers, a state of the art analysis" - ISES Solar World Congress 2013, Mexiko M. Müller, R. Bründlinger, O. Arz, W Miller, J. Schulz, G. Lauss: "Performance of MPP charge controllers - A state of the art analysis" - 28th EUPVSEC Proceedings, Paris

USER PROJECT	DISSEMINATION INITIATIVE
	Michael Müller, Ortwin Arz, Werner Miller Presentation at EU PVSEC 2013 - 28th European PV Solar Energy Conference and Exhibition
	Michael Müller, Ortwin Arz, Werner Miller Presentation at ISES SOLAR WORLD CONGRESS 2013
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USER PROJECT	DISSEMINATION INITIATIVE
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USER PROJECT	DISSEMINATION INITIATIVE
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