DERri
Distributed Energy Resources
Research Infrastructures

TEMPLATE FOR PROPOSAL UNDER DERRI

User-Project Proposal:

User-Project Acronym	PRIME+DER
User-Project Title	Distributed renewable resources impact on narrowband powerline communication on the low voltage network.
Main-scientific field	Research on coexistence of powerline communication technology and distributed renewable resources sharing common physical medium. Scientific fields: signal analysis, AC sources characteristics, data transmissions over low voltage powerlines
Specific-Discipline	Powerline communication, low voltage network analysis

Lead User of the Proposing Team:

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Nationality	Polish
Organization name, web site and address	Institute of Power Engineering (2)
Activity type and legal status* of Organization	Research Institute
Position in Organization	Department Manager

* Higher Education Institution (1) – Public research organization (2) – Private not-for-profit research organization (3) – Small or Medium size private enterprise (4) – Large private enterprise (5) – other (specify)

Additional Users in the Proposing Team:

Name	---------
Phone	---------
E-mail	---------
Nationality	---------
Organization name, web site and address	---------
Activity type and legal status* of Organization	---------
Position in Organization	---------

* Higher Education Institution (1) – Public research organization (2) – Private not-for-profit research organization (3) – Small or Medium size private enterprise (4) – Large private enterprise (5) – other (specify)

(Repeat for all Users)

Date of submission	27.07.2013
Re-submission	YES_____ NO___x____
Proposed Host TA Facility	Tecnalia

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Starting date (proposed)	1.10.2013

Summary of proposed research (about ½ page)

Prepare a ½ page summary describing the relevance and the scope of the proposed work, and the expected outcome(s)

The increasing numbers of smart meters and growing penetration of distributed energy resources connected to low voltage networks will make the coexistence of the two technologies a common scenario. They will share the physical medium – low voltage cabling – for two different purposes: power and data transmission. As power line data transfer heavily depends on the availability and quality of specific frequency ranges, the addition of DERs to the power network should – in ideal case – have no influence on PLC communications. However, the variety of different DER types and its manufacturers, along with different technical implementations of the AC feed can potentially make the described coexistence far from ideal.

The proposed work will focus on researching different scenarios of the DER and PLC coexistence on the low voltage network and mutual influence and dependability of the two technologies. As far as the PLC is concerned, the OFDM based PRIME will be researched, as this technology has been selected by the major DSOs from participating countries (Spain and Poland). In terms of DER equipment, all widely used prosumer-grade solutions will be taken into account – such as wind microturbines and photovoltaic, along with specific solutions like different battery banks – both chemical and ultracapacitor based, diesel generators and flywheel. A lab low-voltage network will be built with a presence of both DER and PLC equipment, and a series of tests will be conducted. The tests will show and describe how the DER-saturated low voltage network will cope with PRIME PLC data transmission. The possible challenges will be identified and thoroughly elaborated. The possibility of practical use of PLC to communicate and control the DERs will be evaluated.

The expected outcome is the research paper covering conducted laboratory tests and their results. These results will be an invaluable source of information for interested parties – such as DSOs , especially useful for planning the low voltage network expansion with a growing saturation of prosumer DERs and PRIME smart metering equipment.

State-of-the-Art (about 1 ½ page)

Describe in brief (in about 1½ pages) the current knowledge on the subject, citing recent relevant references. Identify any knowledge gaps and their relevance.

The current knowledge on the subject is very limited. There is no known research work that has been conducted in the relevant field.

Therefore, the knowledge gaps are numerous. The following areas seem to be most important to cover:

-characteristic of possible interference with the Cenelec A band (as used by PRIME PLC), generated by researched DERs. The characteristics will include exact frequencies, interference levels and its type.

-the interferences generated by grouped (physical proximity on the LV line) and scattered (random or near-random distribution) different DERs. The solutions with the biggest potential of growth – like combined microturbine and photovoltaics and possibly energy storage equipment – will be given a most thorough attention.

-the possibility to use PRIME PLC to monitor and control DERs will be researched. Such use of PLC communication will enable the creation of smart control systems of the DERs with the data communication carried out over powerline network, with no additional data carriers – like GPRS or

short range RF.

-different DERs combinations and different low power network topologies and sizes will be analysed. Also, the penetration level of DERs will be varied in order to cover numerous real-life scenarios in a well-suited lab conditions.

-different PRIME PLC equipment will be used and different interoperability tests will be conducted. This will allow for creating practical implementation guidelines for given PRIME equipment in situations when coexistence DERs and PRIME PLC is required.

References

List relevant References

-PRIME PLC test cases version 1.2 or above

-OpenMeter test cases Deliverables section 4

Detailed Description of proposed project : Objectives – Expected Outcome – Fundamental Scientific and Technical value and interest (2-3 pages)

Provide a detailed description of the objectives of the proposed activity, the way these objectives will be fulfilled through the proposed work, as well as indications on the expected outcome and the fundamental scientific and technical value and interest of the proposal. Specify the type of TA infrastructure (distributed generation simulator; domotic house; etc.) and the test setup. With the understanding that these aspects will be discussed with the TA infrastructure after approval of the proposal and specified in the Agreement to be signed between the TA infrastructure and the User team, indicate the number of tests to be carried out and their sequence, the response quantities to be measured through the instrumentation, etc. Describe any special requirements for equipment, standards, safety measures, etc. Point out any shortcomings, uncertainties and risks for the fulfillment of the project objectives, as well as the means to mitigate relevant risks.

<u>Test setup</u>

The number of different test setups will be created.

They will vary depending on:

-the number of PRIME PLC switch nodes connected to the LV network

-the number and type of the DERs connected to the LV network

At least three different test setups in terms of complexity will be created:

-single type DERs: PV

-mixed, typical DERs: PV and wind microturbine

-mixed, all available types of DERs available at the lab

A number of topologies will be tested, including the following:

-DER connected alongside the smart meter - typical prosumer scenario

-DER connected in a specific distance from the smart meter and specific distance from the base node

-DERs interleaved with the smart meters (worst case type scenario)

-DERs surrounding the base node (another worst case type scenario)

Expected outcome

A paper elaborating on:

-technical aspects of the coexistence of PRIME PLC equipment and distributed renewable resources.

-practical observations and conclusions drawn from the carried out lab tests

-a set of problem mitigation solutions

-a study on the possibility of using the PRIME powerline communication to monitor and control DERs

Scientific value

Researching the behaviour of the low voltage PRIME PLC based data communication in the environment with many connected DERs.

Researching the possibility to use PRIME PLC a communication technology for data transfer between DERs and master control station

Technical value:

The project in its technical aspects will bring the following benefits:

-research on the signal interference generated by various distributed energy resources in the CENELEC A band

-research on the resilience of PRIME PLC data communication to different interferences in a number of simulated real-life scenarios, covering various topologies, equipment setups and combinations

Originality and Innovation of proposed research – Broader Impact (1-2 pages)

Demonstrate the originality and innovation of the proposed work and the impact the expected results will have on current and future research or practice, public safety, European standardization, competitiveness, integration and cohesion and on sustainable growth.

The innovation potential of the proposed scope of work seems to be very high.

With the proliferation of distributed energy resources (its level varying from country to country) and EU directive on smart meters deployment, under the terms of the Third Energy Package, the coexistence of these two technologies will be inevitable.

As far as the distributed system operators (DSOs) are concerned, these companies will have to cope with technical challenges caused by the ever increasing use of the above technologies. One of the main areas of the possible uncertainty is the impact of various DERs, connected to the low voltage network, on the powerline data communications. The number of different inverter designs – or energoelectronic circuitry in general – may pose significant risks for the possibility and effectiveness of the powerline communication.

The situation where DERs are severely limiting or even disrupting powerline communication is from the DSOs perspective quite unacceptable. The choice between smart meter deployment and DERs growth is a false one. In order to take the right preemptive steps and fully assess the current situation as well as to identify the future challenges, the proper research work should be carried out.

As the smart metering and possible set of value added function based on smart metering networks (like emergency demand reduction due to the use of meter power limiting capability,

communication with Home Area Network equipment, other media meters readouts) can be considered as critical infrastructure strongly tied with public safety, disruption of its functions may cause severe and widespread damages and impair the region or country effectiveness.

Taking into account the above ramifications, the proposed project will lay significant foundations for uninterrupted, harmonised growth and proliferation of both the smart metering and distributed energy resources. Moreover, in case when the project results justifies the drafting of the specific recommendations for smart meter and DERs vendors, such step will be taken.

Proposed Host TA Infrastructure/Installation – Justification (about one page)

Specify the type of TA infrastructure (e.g. distributed generation simulator; domotic house; etc.) and if possible which one of the 13 TA Infrastructures in DERri may better serve the scope of the proposed research. Justifications should be provided on the grounds of the test set-up, testing method, equipment, past experience in relevant subject, etc. State whether the TA User team intends to deliver to the premises of the TA Infrastructure parts or components to be tested at the TA User's expense and responsibility, or to cover the whole or part of the construction/adaptation cost of the specimens to be tested.

As far as the Tecnalia TA equipment is concerned, the following pieces of equipment will be used:

-Photovoltaic installations: single-phase 0.6 kW, single-phase 1.6 kW and three-phase 3.6 kW

-Diesel Generator: 55 kW

-Microturbine MAGNETEK EG-50: 50 kW.

-Wind turbine INCLIN NEO 6000: 6 kW, 4m rotor.

-Fuel Cell-based controlled power source

-Flywheel UPS Caterpillar: 250 kVA. Uninterruptible power supply system based on flywheel energy

-1120 Ah Battery Bank.

-5kW Ultracapacitor-based UPS

The following PRIME PLC equipment will be used:

-at least 2 different PRIME base nodes (data concentrators)

-at least 7 different PRIME switch nodes (energy meters) – both single and three phase models

An appropriate set of passive equipment (cables, filters, connectors, network analysers etc) will be used.

Synergy with ongoing research (about ½ page)

Provide information on any concurrent research project with the same or similar subject with the one proposed. Describe the synergy (if any) that will be sought between the existing and the proposed project.

The tasks carried out at Tecnalia premises are complementary to some of the R&D projects that Tecnalia has been involved in regarding demand response and integration of distributed resources. Some of these projects are:

iGreengrid: The objective of FP7 iGreengrid is to evaluate the main demonstration projects in Europe regarding the integration of Distributed Renewable Energy Sources, to understand how different solutions have been successfully adopted in different regions and try to replicate them

across Europe. The application of accurate KPIs to select the most promising solutions and a comprehensive techno-economic simulation to see how they can be applied in other circumstances are some of the key challenges of the project.

EcoGrid (http://www.eu-ecogrid.net) The key objective of the EcoGrid is to demonstrate the efficient operation of a distribution power system with high penetration of many and variable renewable energy resources. The EcoGrid demonstration will take place on the Danish island Bornholm with more than 50 % electricity consumption from renewable energy production. Of a total of 28 000 customers on Bornholm, approximately 2000 residential consumers will participate with flexible demand response to real-time price signals.

PIME'S, Microgrids based Solutions for CONCERTO communities (http://www.pimes.eu/) PIMES is a joint CONCERTO initiative in which are involved the villages of Salburua in Vitoria (Spain), Dale in Sandnes (Norway) and Szentendre (Hungary). The three communities work together on research and technological development, as well as demonstration and dissemination activities to develop a quarter/district or eco-community energetically sustainable, based on the microgrid concept, which could be replicated in other countries.

ADDRESS: Active Distribution networks with full integration of Demand and distributed energy RESourceS (http://www.addressfp7.org/) This project, led by RWE and funded by the EC under the FP7, aims at developing new network planning tools and methods for European DSOs for an optimised large-scale roll-out of electromobility in Europe whilst at the same time maximising the potential of DER integration. For the validation activities the project will rely on existing infrastructures of the four involved DSOs and the cooperation with OEMs.

Energos: Active Demand Management (http://innovationenergy.org/energos/index.php) Energos is a research project for the development of knowledge and technologies for the implementation of Smart-Grid that integrate and manage in real time the interface with the users connected to this grid: energy generators, energy consumers , etc., in order to achieve an efficient, safe and sustainable energy supply.

SAREBAT Active Demand Management SAREBAT's purpose is the development of equipment and systems for the automation of transformation centres and for the automation of the whole distribution grid. SAREBAT will involve monitoring and control, internet external access to information, detection of mishaps and algorithm development for energy management.

EU-DEEP: The birth of a European Distributed EnErgy Partnership (http://www.eu-deep.com/)

EU-DEEP was born to design, develop and validate an innovative methodology, based on future energy market requirements, and able to produce innovative business solutions for enhanced DER deployment and for the removal of technical and non-technical barriers in Europe 2010.

Dissemination – Exploitation of results (about ½ page)

Describe the means through which the results to be obtained from the proposed project will be diffused and made broadly known.

The results in a concise form will be published by both Tecnalia and Institute of Power Engineering web page.

Moreover, all recommendations regarding the PRIME meters usage for demand response, renewable integration or grid operation functions will be made available for the DSOs in Spain and Poland, for the PRIME Allinace, and both Institute of Power Engineering and Tecnalia will try to write a paper and present it in a relevant Smartgrids congress with the main conclusions of the work performed during this collaboration.

Time schedule (about ½ page)

Provide an indicative time-schedule for the proposed work and a target starting date.

1.10.2013 – start of the project
1.10.2013 – 6.10.2013 – lab equipment completion and configuration
Scope: connecting the distributed energy resources
connection the PRIME PLC equipment
preparation for different network topologies

7.10.2013 – 31.10.2013 – carrying out the planned tests.
1.11.2013 – 30.11.2013 – preparing the final report
1.12.2013 – report published

Description of the proposing team (as long as needed)

Give a short description of each member (organization and persons) of the proposing team including publications, experience in test campaigns and role in the proposed project.

Institute of Power Engineering team member:
-experience in PRIME PLC data communication
-experience in data equipment interoperability test
-experience in signal interference analysis

Tecnalia team members:
-experience in defining and carrying out specific PLC equipment test cases
-experience in interference injections, types of interferences and their mitigation
-experience in connecting the distribution energy resources in a simulated lab environment

Last year publications of the Team:
Tecnalia publications:
-IECON 12: Stability analysis and design of droop control method in dq frame for connection in parallel of distributed energy resources
-IEEE EnergyCon 2012: Toolbox for an Aggregator of Flexible Demand
-IEEE Smart Grid Newsletter: What the Semantic Web Will Mean for Smart Grids
-IET Renewable Power Generation: Design and implementation of droop control in d-q frame for islanded microgrids
-26th International Electric Vehicle Symposium - EVS26: A whole approach for the Electric Vehicle Infrastructure in the Basque Country

Institute of Power Engineering publications

-DLMS/Cosem Meter Profile for Energa Smart Metering Project

-Smart Grid Roadmap for Energa

-FDIR and IVVT functions study and software implementation for Smart Grid

Team Leader:

Ibon Arechalde:

Low Voltage and Smartmeters Lab. Manager.

Publications:

Arechalde-Ugertache I., Madina C.: “New smartgrids, metering and demand side management”. DYNA Ingenieria e Industria. June 2011. Vol 86-3 p.300-317

Team member:

Iñigo Cobelo

Smartgrids Team Member

Publications;

State Estimation of Networks with distributed generation- European Transactions on Electrical Power, Jan-Feb 2007.

A Direct Load Control Model for Virtual Power Plant Management - IEEE Transactions on Power Systems, Vol. 24, N 2, May 2009.

Team member:

Aleksander Babs

Manager of the Software Engineering Department at Institute of Power Enigineering in Gdansk, Poland.

Publications:

"ICT in a smart grid based energy services development”, CIRED 2013 published paper.