DERri
Distributed Energy Resources
Research Infrastructures

ANNEX 2: TEMPLATE FOR PROPOSAL UNDER DERRI

User-Project Proposal:

Use-Project Acronym	*ITEM_GC SYSLAB*
User-Project Title	*IMPLEMENTATION AND TESTING OF A ELECTRICAL MODEL BASED ON THE ISLAND OF GRAN CANARIA, IN SYSLAB FACILITY*
Main-scientific field	Electrical Engineering
Specific-Discipline	Power flow models

Lead User of the Proposing Team:

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Nationality	Spanish
Organization name, web site and address	Department of Electrical Engineering of the University of Las Palmas de Gran Canaria (ulpgc) Web site: www.ulpgc.es Address: Edificio de Ingenierías, Campus de Tafira, 35017 las Palmas (Spain)
Activity type and legal status* of Organization	Higher Education Institution (1)
Position in Organization	Post Degree Student

* 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)

Date of submission	29/09/2010
Re-submission	YES_____ NO___X___
Proposed Host TA Facility	RISOE DTU
Starting date (proposed)	11/01/2011

Summary of proposed research

At the Department of Electrical Engineering of ULPGC there has been going on a relevant research on the transmission and distribution grid of the island of Gran Canaria, including how the whole system behaves against different contingencies that may arise during operation.

It's also being researched the power income from wind power generators and it effects, during a variety load states.

Different models have been built, using software platforms (such as Simpow), in order to test the grid.

The idea is for the applicant, to build the model implemented on software, at SYSLAB facility, using the elements and equipment, and comparing the results obtained. By this work with real data, he'll be getting a privileged knowledge of how the system mounted at the lab works, and be able to extrapolate that knowledge to the real system.

State-of-the-Art

The Gran Canaria Island's electrical grid has been a major challenge for the engineers, ever since the renewable energy started to be a part of the system. The grid is set completely isolated, the main reason why the stability of the system tend to be low. There has been some research about connecting the different islands together in order to increase the electrical inertia of the whole network, but so far it has been difficult to overcome some problems that have arisen (as the depth of the ocean between the islands). In figure 1 is shown the high voltage layout of Gran Canaria.

Meanwhile, the power supply to the grid coming from wind energy is increasing, with a new project plan ahead to build a wind park on the south west, close to the airport, tending to increase the amount of power supplied by renewable energy. Certainly, the island has many resources of natural energy (not just wind) that need to be exploited [1].

At the moment the great majority of the wind turbine generators installed are asynchronous conventional wound rotors machines with fixed speed operation. However, for the new project the intention is to bring the newest machines up to the system.

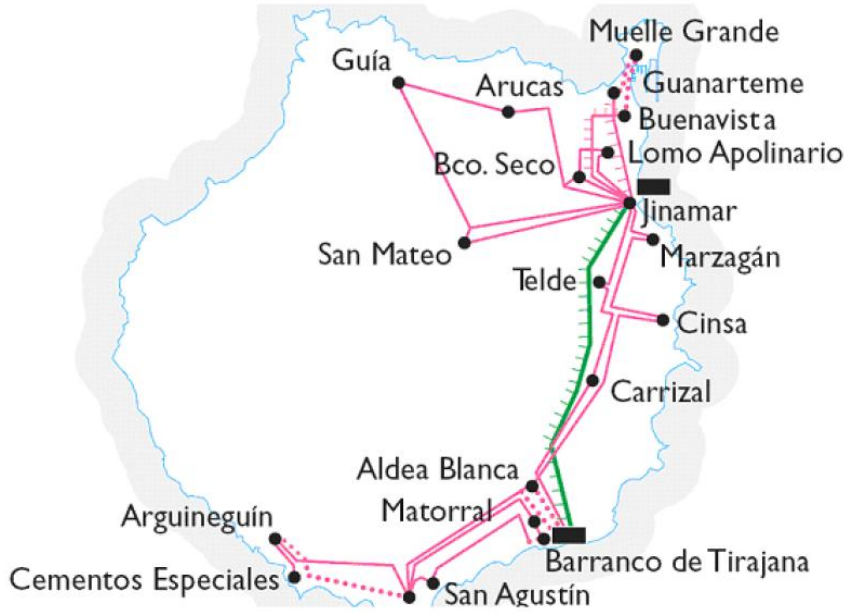

Figure 1. Gran Canaria Island's electrical grid, high voltage layout (provided by Red Eléctrica España).

There are two main power plants installed (as it can be seen in figure 1), the one in Jinamar supplying 385 MW (around 40% of the energy produced) and the one in Barranco de Tirajana supplying 416MW (around 44% of the energy produced), there are also installed a few diesel generator units to back up the power plants and the whole system.

Due to all the factors just mentioned, it arises the need to build reliable models to predict the behavior of the system. Such models precise the right parameters from the different elements configuring the grid, and they make it feasible to test different faults in those elements to predict the outcome of the whole system.

At the Department of Electrical Engineering of the University of Las Palmas de Gran Canaria it's been going on some work aiming this direction, of modeling electrical systems and studying the impact of the new wind farms that are going to be installed, as well as studying the way to take profit of the natural resources available [2], to make it grow in a sustainable way.

A model has been designed, by gathering all the required data, in order to make the necessary tests [3]. Up to 60 nodes has been included, to build both power flow models and dynamic models.

The biggest issue that has been encountered during this research has been the recollecting of all the data needed, and mainly checking whether the results fitted the real behavior of the system. The access to the parts of the electrical system has been reduced due to the privacy policies of the electrical companies.

References

[1] N. Angulo, J.F. Medina, F. Déniz, J. Cidrás, F. Díaz, C. Bueno, *Dynamic Analysis of an Isolated Hybrid Wind/Hydro/Diesel power System for Water Desalination*, Wind Power for the 21 st Century, 25-27 September 2000, Germany.

[2] J. Kabouris, G.C. Contaxis, *Planning of Water Desalination Plant in Conjugation with Wind Energy Penetration in a Small Island System*, European Union Wind Energy Conferences, 20-24 May 1996, Sweden.

[3] N. Angulo, J.F. Medina, J. Cidrás, *A Contribution to the Short-Circuit Analysis of Weak Networks Containing Wind Turbines*, European Union Wind Energy Conferences, 2-6 July 2001, Denmark.

Detailed Description of proposed project : Objectives – Expected Outcome – Fundamental Scientific and Technical value and interest

The electrical system of the island of Gran Canaria presents many factors to be improved. The great majority of the energy consumed, comes from fuel-oil turbines whose emissions to the atmosphere are rather high. The storage issue hasn't been address yet, although the new income in wind power should make this problem a priority.

The impending changes that the whole network is going to suffer, makes it essential to acquire a good knowledge of how the system could be balance.

For the proposed project, the main objective is to implement on the SYSLab with the equipment mounted, the model of the electrical power flow of the island of Gran Canaria that has been developed on Software. For this objective to be fulfilled there are some targets to be addressed, as the ones described below:

- Once the full description of the model and the model itself has been carried out (by the ULPGC team work); it'll be needed to share it with the RisoeDTU team, and make the necessary modifications, in order to implement it with the equipment available at the lab.
- There'll be carried out some tests, such as short circuits on different parts of the model, variations on the type of load, etc. and the behavior of the system against them will give a better understanding.
- The inclusion of new possibilities on the network is another important objective to fulfill. At SYSLab there are available equipment based on new technology, that could solve some of the problems of the network (i.e. using the batteries mounted on the laboratory could be a way to improve the storage issues).
- Once the system has been well tested, some measurements will be taken in order to improve the functioning of it against the different contingencies.

Finally when these parts are completed, the applicant will write all the conclusions gathered during the work, and the procedure taken throughout the whole task.

Originality and Innovation of proposed research – Broader Impact

Nowadays, electrical isolated systems are rare. The mainland is widely connected to reach almost every point. However some islands entail difficulties to provide the inhabitants with electrical energy.

The main parameters, frequency and voltage, of the grid oscillate too much, which implies the need of unballasting some part of the grid to avoid the appearance of failure at any part.

The income of power supply from renewable energy makes it even more important to understand every part of the system, test it for many contingencies, and have back up plans to use in case they happen.

With the project that it is proposed, there'd take part an exchange of information in both ways, the ULPGC team could share the expertise they've gather through all these years working with an isolated grid, while the RisoeDTU team could share their knowledge of working with the parts mounted at SYSLab and how to collect and analyze the real data.

Proposed Host TA Infrastructure/Installation – Justification

The chosen TA infrastructure has been RisoeDTU SYSLab facility, for many reasons. In first place, it adapts very well to the previous work that has been done, containing parts such as:

- 3 substation switchboards + 1 crossbar switchboard;
- 1 tap-changing transformer;
- 50 kW diesel generator set;
- 10 kW wind turbine;
- 50 kW wind turbine;
- 10 kW PV solar panels;
- 20 communication nodes.
- …

All these components fit very well with the model implemented on Software. The components of the lab are communicated in such way, that a computer stores all the data from the different parts to be analyzed.

Another good reason for choosing SYSLab is that it provides flexible setup with on-line change of topology, which allows implementing a great variety of systems using the parts available.

Those main reasons just commented; make RisoeDTU the most suitable infrastructure

for the proposed project to be developed.

Synergy with ongoing research (about ½ page)

A related project dealing with the electrical system of an isolated network is: “Central Hidroeólica de El Hierro”. It was promoted by local authority Cabildo de El Hierro and the local utility Unelco-Endesa. It was related to build an autonomous power system for El Hierro Island (also on the Canarian archipelago), mostly depending on wind energy but aided by hydro and diesel units.

In the comparison we find that the electrical system of Gran Canaria is much more complex, is integrated by a greater amount of parts, and provides more power to the grid. However the main idea remains, trying to take advantage of the renewable resources.

The idea of installing hydraulic plants and a pumping system, as a way to store the energy and use the remaining of the wind energy supply when not consumed to pump the water up, was the main support of the El Hierro project, and it’s being study on Gran Canaria as well, by the ULPGC team.

Dissemination – Exploitation of results

The idea is for the applicant, once finished the work at RISOE, if the results achieved are satisfactory, present them either on a conference or as a paper on a technical journal.

Time schedule

The period in which the applicants work will take place expands throughout 3 or 4 weeks. A draft has been built, in order to assign each task enough time to complete the overall project.

1. Presenting the model and coming into contact with the lab’s equipment: the applicant should spend some time adjusting the model if necessary and presenting it to the team work at SYSLab, as well as getting to know the whole facility.
2. Implementing and testing the model: first the model should be implemented as accurately as possible, using the parts at SYSLab. Then the data outcome should be analyzed and compared with the software model.
3. Final report: with the conclusions extracted during the analysis of the data, a report will be written and presented both to the TA team work and to the team work at the ulpgc.

In figure 2, it’s shown a possible chart of how the time could be assigned to each point.

As it was said before, this is just a possible distribution of the time, and it could be modified according to the needs at RisoeDTU infrastructure.

	First Week	Second Week	Third Week	Fourth Week
Task 1				
Task 2				
Task 3				

Figure 2. Time schedule.

The intended starting date is 11/01/2011.

Description of the proposing team

Lead User: Pablo Horstrand Andaluz

Industrial Engineer

Education

2010 : Completed the university degree by handing the final project, awarded with honours.

2008 : Followed the Summer School in Wind Turbine Technology (in Aarhus).

2007/2008 : University of Southern Denmark (Odense), following the Erasmus programme.

2006 : Awarded a scholarship by the goverment of the « Cabildo de Gran Canaria » for the excellent student achievement.

Competences

Software : Matlab and Simulink, C and C++ languages, Neplan.
Operating Systems : Windows and Mac OS X.

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Work Experience

2009 : 8 months working stage at IUMA, microelectronics institute, developing a project of image processing on a board, based on a Virtex 5.

2008 : 6 months working stage at SIANI, institute of mathmatics, developing a software platform.

Tutor: Dr. Norberto Angulo Rodríguez (Profesor Titular de Universidad)
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Personal Data

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Conferences attended

N. Angulo, J.F. Medina, F. Déniz, J. Cidrás, F. Díaz, C. Bueno, *Dynamic Analysis of an Isolated Hybrid Wind/Hydro/Diesel power System for Water Desalination*, Wind Power for the 21 st Century, 25-27 September 2000, Germany.

N. Angulo, J.F. Medina, J. Cidrás, *A Contribution to the Short-Circuit Analysis of Weak Networks Containing Wind Turbines*, European Union Wind Energy Conferences, 2-6 July 2001, Denmark.

N. Angulo, F. Díaz, J. Cruz, J.F. Medina, C. Bueno, J. Cidrás, *Energy Supply to a Small Island by Wind and Hydro Power: Dynamic Analysis*, Global Wind Power, París 2002.

N. Angulo, *Analysis of the behavior of asynchronous wind turbines under network frequency variations*, European Union Wind Energy Conferences, 16-19 June 2003, Spain.