DERri
Distributed Energy Resources
Research Infrastructures

APPENDIX 2: Template for proposal under DERri

User-Project Proposal:

Use-Project Acronym	TESCABI
User-Project Title	**Te**sting **s**cheme for MPPT **c**harge controllers and **b**attery **i**nverters
Main-scientific field	Laboratory tests with power electronic devices
Specific-Discipline	Development of testing procedures and power converter tests.

Lead User of the Proposing Team:

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Activity type and legal status* of Organization	Large private enterprise (5)
Position in Organization	Director PV off-grid

* 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:

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Position in Organization	Steca electrical laboratory

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* 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	28.2.2012
Re-submission	YES_____ NO__X_____
Proposed Host TA Facility	AIT - Austrian Institute of Technology, Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H.
Starting date (proposed)	1.4.2012

Summary of proposed research (about ½ page)

The proposed project is significantly relevant to both, R&D and the PV-Industry. Due to the cost reduction especially for grid-connected PV-modules MPPT charge controllers are of more and more importance for all kind of off-grid applications. It makes sense to invest in MPPT chargers just to be able to use cheap grid-connected solar modules. Also the average system size rises. This also supports the usage of battery inverters as well as MPPT charge controllers. For both, battery inverters and especially MPPT controllers today it is difficult for end users to compare different products as manufacturers often do not give relevant and sufficient information. Furthermore, it is difficult to compare given values as most values refer to different criteria.

At this point the present project starts in order to develop relevant and standardized test procedures for both battery inverters and MPPT charge controllers. For both product types different models of several manufacturers will be measured and compared during the lifetime of this project.

The outcome of this project will be the development of a representative neutral test procedure for battery inverters and MPPT charge controllers which can be made available to all manufacturers. Since the testing method will allow to compare the tested products, a relevant “best product list” for the specific mentioned product category can be generated. The results will be presented to manufacturers and to the PV industry during the largest annual PV conference (PV SEC).

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State-of-the-Art (about 1 ½ page)

Generally the proposed work is to test power electronics equipment. Therefore, all available knowledge for testing such products can be used and shall be applied. Especially DC-DC (MPPT charge controllers) and DC-AC converters (battery inverters) are in the focus of this project. Especially within AIT there exists long term experience in testing grid connected DC-AC inverters. Part of this experience and laboratory equipment can be also used for DC-DC converters. Especially the measurement of the accuracy of the MPPT algorithm can be done in accordance with the test procedure of DC-AC grid tied inverters. This is an important basis and know-how to get started efficiently.

Generally, it is important for MPPT charge controllers to offer high efficiency converting especially to get the battery charged quickly during periods of low irradiation. Beside this, in off-grid systems, the situation appears that during high irradiation the battery is fully charged and the load fully supplied by the power from the solar module. The additional available power cannot be used in the system. It should be analyzed what kind of behavior MPPT controllers offer in this operation mode. Furthermore, a good strategy how to deal with this situation has to be identified and shall be dealt with as a gap of knowledge.

References

Relevant references to evaluate MPPT charge controllers are:

- Test procedures for maximum power point tracking charge controllers characterization, María Camino Villacorta, Miguel Angel Egido Aguilera and Pablo Díaz, Instituto de Energía Solar, Universidad Politécnica de Madrid, Ciudad Universitaria s/n, 28040 Madrid, Spain
- IEC 62109, International standard, Safety of power converters for use in photovoltaic power systems - Part1: General requirements (IEC 62109-1:2010); German version EN62109-1:2010
- IEC 62509, International standard, Battery charge controllers for photovoltaic systems - Performance and functioning (IEC 62509:2010); German version EN 62509:2011

Synergy with ongoing research (about ½ page)

Module integrated or module mounted power electronic devices are becoming increasingly popular in the PV Balance-Of-System (BOS) components sector whereas the optimization of the conversion efficiency as well as Maximum Power Point Tracking MPPT is in the focus of R&D activities. A number of ongoing research projects are dealing with the development and research on small scale high performance power conversion units, like the EC FP6 project PV-MIPS (www.pvmips.org), and the Austrian national project IPOT (www.ipot-project.at) which deals with the improvement of the functionality of solar modules by integration of MPP trackers.

Generally, new products need to be tested to check the functionality and the specified features. Therefore, inside Steca there are existing detailed product test procedures especially for switching charge controllers which are used during DVT tests internally. The proposed project will have a dual benefit: on the one hand researchers can make use of the already existing and ongoing tests inside the Steca laboratory as an important input for the pursued objective. On the other hand, the solid know-how and up-to-date infrastructure of a renowned testing unit like AIT will complement and foster the development of a novel approach for this specific procedure which can be jointly developed and conducted.

Dissemination – Exploitation of results (about ½ page)

The proposed work offers good possibilities for dissemination. First of all, the test scheme itself as well as the outcome of tests of the sample products (best product list) shall be submitted and presented as a paper for the largest PV-event in Europe, the PV-SEC conference. Some other international conferences to be defined might be suitable to present the results as well.

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

This work aims to bring light into the darkness of MPPT data sheets among different manufacturers. Up to now especially for MPPT charge controllers we can find the situation that critical information about the product is often not listed in the data sheet. Thus, the key interest of this work is to standardize the testing procedures of MPPT charge controllers and battery inverters. Based on that it is the goal to reach more transparency in terms of the given values in the data sheets. Project results will make it easier for installers and users to compare MPPT charge controllers on a neutral and technically absolute correct level, with testing performed under standardized testing conditions.

Beside this it is the goal of this work to identify technical problems and weak points in existing MPPT charge controllers. Many new MPPT charge controllers are designed to be as cheap as possible taking e.g. into account that the nominal power can only be handled for a couple of minutes. Then the controller starts to derate, and to limit the output power. This reduces the energy yield and leads to low performance of the off-grid system especially during periods of low irradiance which can be critical for the system. At the same time it is difficult for the user to identify such problems. By testing the samples weak points (like the example mentioned above) can be identified and categorized as well as compared among different manufacturer products. This shall be done in order to be able to advise manufacturers on how to improve their products.

First of all a testing scheme for MPPT charge controllers and battery inverters shall be defined. This can be done on the base of the existing knowledge at Steca and the testing experience of AIT. Once testing procedures are defined several different MPPT charge controllers and battery inverters shall be tested with the facilities of AIT among the defined scheme.

The existing equipment at AIT is necessary to do the tests. First of all, a powerful module simulator is necessary to feed the MPPT charge controller under defined conditions. The MPPT charge controller itself has to be connected to a real battery. The existing battery at AIT shall be used. To be able to run the MPPT charge controller under different defined conditions there must be a possibility to discharge the battery. This shall be done by using a battery inverter which shall supply standard AC-loads. To be able to measure all values and to monitor the behavior of the components, different multi-meters and digital storage oscilloscopes are necessary and shall be used to gather the data. Finally, the recorded data have to be analyzed and brought into readable format in order to disseminate the results.

The whole process has to be supported by AIT staff in order to be able to perform efficiently.

To start the first sample tests three different MPPT charge controllers shall be measured in the AIT laboratory among the specified testing scheme. Beside this the battery inverter shall be used and measured during the tests as well. After the laboratory test the MPPT charge controllers shall be installed in the AIT testing site for data monitoring under real life conditions. Therefore, the charge controllers shall be connected to the same battery, the test solar module array available from the facade shall be connected to the charge controller while the inverters will feed a periodical load such as AC night lights. Furthermore, around the MPPT charge controller a data monitoring system shall be implemented in order to record all data. This real-life testing system shall be operating independently for about 2 months. The collected data shall be analyzed. This will lead to important information to verify the significance of the laboratory test procedure. Moreover, it will underline the

importance of the detailed data information on the base of the data sheets as the real life testing will show significant performance difference of good MPPT charge controllers in comparison with cheap and simple products.

In terms of safety all general standard rules of electrical power laboratory apply and have to be respected. Special safety rules apply in the DC-input circuit between the solar module simulator and the MPPT charge controller as DC voltages of up to 200V might appear.

The proposed work can immediately start on the base of the existing knowledge of Steca and AIT. A limited risk to fulfil the project target can be seen in the products themselves. In case the sample controllers should all perform well (which is not to be expected), the outcome of the project would just be to have a valid specified testing scheme available for further product investigation.

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

Up to now there do not exist standardized testing procedures for MPPT charge controllers and battery inverters. This project shall deal with this matter and establish comparable test procedures. The developed test procedures will allow comparing products from different manufacturers more easily. This can lead to more transparency for the whole PV industry to estimate the functionality and the quality of different products on a reasonable base.

Also for new products this can lead to the situation that manufacturers include the given test scheme and requirement to their product specification already during development status. This means that upcoming products are of higher quality as they already implement good solutions for weak points which are identified by this project. Manufacturers will like to present products which perfectly comply with the proposed standardized testing procedure. This means in a long term prospective this work can improve the quality of available products.

Moreover, it brings a benefit for the work for European standardization processes. The outcome of this project can be a first starting base for harmonized European testing standards for MPPT charge controllers and battery inverters.

The standardization of test procedures also supports a further growth of the off-grid market as it improves the quality of the used products and allows users to decide in a reasonable way which product to use. This improves the quality of the installed systems. Also it makes the systems more reliable which finally leads to successful systems which are the most important point for all players to foster and establish a growing market.

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

The AIT - Austrian Institute of Technology, Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H. already performs a huge variety of different power electronics tests for the PV industry. Grid-tied inverters play an important role in the test lab. As MPPT charge controllers are similar products it is obvious that the best place to develop test procedures and to perform the tests is an experienced institute like AIT. Therefore our choice would be that the work shall be done at AIT labs.

The advantage is also that the necessary equipment is already available at AIT. For the testing the following equipment is necessary:

- Module simulator (voltage range 17-250V DC, output power about 3kW, output current 0-60A DC)
- Battery inverter (to be supplied by Steca)
- Battery bank (48V)
- Measurement devices
    - Power Analyzer, multiple power measurement channels
    - Multi Channel Digital storage oscilloscope
- Loads
    - Electronic DC load
    - 3 x RLC AC loads, continuously adjustable, 12kW, 21 kVAr
- Sources
    - AC source (3 phase and single phase)
    - DC source (3 string PV Array Simulator)
    - Public grid
- Components
    - 3 * MPPT controllers
    - 3 * battery inverters
    - Data monitoring of all electrical parameters
    - Data analyses software for MPPT efficiency and data analyses.

Steca will deliver the mentioned components, all other equipment for the tests should be available at AIT.

Time schedule (about ½ page)

The proposed project shall ideally start in April 2012.

First of all the development of the test procedures is the most important first package. This can be done locally at Steca with the help of the knowledge from AIT staff. This package shall be done within 10 working days and shall be finished end of april 2012.

During May 2012 the tests shall be prepared at AIT. First components have to be supplied to AIT. Steca will do this. Furthermore, Steca will source the necessary test components, the battery inverters. AIT will prepare the AC loads and other necessary equipment.

The tests at AIT shall start in June 2012. Overall 20 working days shall be necessary to test the components. The tests shall be finalized at the end of July 2012.

Finally the test protocols shall be analysed and summarized during August and September 2012 in order to be able to disseminate the outcome during PV-SEC 2013.

Description of the proposing team (as long as needed)

Steca Elektronik GmbH:

As a leading supplier of products for the solar electronics industry, Steca sets the international standard for the regulation and control of solar energy systems. In the three market segments PV grid connected, PV off grid and Solar thermal, the Steca brand is synonymous of innovation and vision. In conception, development, production and marketing, the company is committed to the highest quality standards. Its focus is on made-to-measure solutions for the effective utilization of solar radiation. Furthermore, Steca continually examines the technologies it has developed with a view to simple operation and, consequently, usability for the wide base of the population - worldwide.

Mr. Michael Müller, director PV-off-grid at Steca will be responsible for the development of the test procedures.