DERri
Distributed Energy Resources
Research Infrastructures

TEMPLATE FOR PROPOSAL UNDER DERRI

User-Project Proposal:

User-Project Acronym	DRSSG
User-Project Title	Demand respond strategy for smart grid
Main-scientific field	Energy optimization/ Smart grid
Specific-Discipline	Smart grid

Lead User of the Proposing Team:

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Organization name, web site and address	Technical University of Sofia, branch Sliven; http://www.tu-sofia.bg/eng_new/index.html ; Sliven, 59 Burgasko shousse
Activity type and legal status* of Organization	Higher Education Institution
Position in Organization	Assistant Professor

* 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	18.03.2013
Re-submission	YES_______ NO___X____
Proposed Host TA Facility	TA 7; KEMA; Arnhem; NL
Starting date (proposed)	01.05.2013

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)

Integration of the low capacity value of intermittent generation, accompanied with possibly very significant increases in peak demand driven by transport and heating electrification, may lead to very significant degradation in the utilisation of generation infrastructure and electricity network assets . As a result,system integration costs are expected to increase considerably.

Energy storage technologies have the potential to support future system integration. However, the potential value storage brings to the system, and therefore its cost targets, are poorly understood to date. A comprehensive whole systems analysis approach is developed in this study to establish the role and quantify the value of electricity storage, alongside alternative technologies, in facilitating cost-effective evolution to a low carbon future.

In this context the key objective of this work is to model and analyse the value of grid -scale storage in the future electricity systems.

As the PV battery system will be a component of branch of smart grid I would like to study available storage technologies for systems up to 300 kW.

The study aims to assess:

1. Different type of batteries for grid stabilization, depending on the storage operational time, with the response and ramp times must be well under a second.
2. Differently situated PV battery system for ensuring customer load in a branch of the distribution grid.
3. Battery systems optimal capacity needed to cover PV fluctuations in a branch of the distribution grid.

I also aim at developing a model to design a differently situated PV battery system to ensure demand response in a branch of distribution grid.

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 scientific studies and the experience in the field of demand response is limited and insuficient. It has to be mentioned that in the Bulgarian National Energy Strategy 2020, a special priority focus is given to the consturction of the Smart Grids, and inclusion of renewable energy sources in them. That is why scientific research has to be intensified and concrete steps for construction of Smart grids to be taken, which will reform the highly centralized Bulgarian energy system. Thus the energy efficiency will increase in the distribution grids and greenhouse gases will be reduced.

The research done in this filed has been conducted by Cockroft, N. Kelly (2006), who did a comparative assessment of future heat and power sources for the UK domestic sector. Some other authors like Fletcher, D. Kane (2008) worked on a model for evaluating the impact of battery storage on microgeneration systems in dwellings. Cames, C. Fischer, B. Praetorius, L. Schneider, K. Schumacher et al. (2006), Micro cogeneration Springer (2006)) on the basis of daily/yearly load; where it is assumed that all the energy produced will be consumed. It is granted that the energy will be consumed - no matter whether at the moment of energy production or it will be stored. However, all these studies do not pay enough attention on the synchronization of production and consumption – demand response.

Some other studies propose a solution to the problem with the instability of the energy production, by assuming that all the energy produced will be directly feed-in to the grid (Bahaj et al. (2007), Watson (2004)) and the efficiency is measured by the CO_2 emissions saved.

Another point of view is shared by (E. Lemaire-Potteau et.al. (2006)), Elhadidy et. al., (1999),

Ross J.N et.al., (2000), M.M. Mahmoud (2004), J.D. Maclay et.al., (2006), believes that the energy produced has to be accumulated on place.

It is generally accepted that the integration of intermittent energy resources like photovoltaics into an electricity system cannot exceed a limit of around 20% or 25%, see, e.g. [EWEA, 2005. Large-scale integration of wind energy in the European power supply: analysis, issues and recommendations. The European Wind Energy Association]. However, the decoupling of electricity generation and consumption can be implemented with use of electricity storage.

References

Alexander E. Farrell Electricity, *Environmental Impacts of Encyclopedia of Energy*, 2004, pp 165–175;

Bahaj, A.S., L. Myers, P.A.B. James Urban energy generation, *Energy Build*, 39 (2007), pp. 154–165

Denholm, P.; Margolis, R. M. Evaluating the limits of solar photovoltaics (PV) in traditional electric power systems, *Energy Policy*, Volume 35, Issue 5, May 2007, Pages 2852–2861;

Electric Power Systems Engineering Encyclopedia of Energy, 2004, pp. 267-287

Elhadidy M.A., Shaahid S.M., Optimal sizing of battery storage for hybrid (wind + Diesel) power systems, *Renewable Energy*, 18 (1999), pp. 77

Fthenakis V.M., Nikolakakis T., Storage Options for Photovoltaics, *Comprehensive Renewable Energy*, Volume 1, 2012, Pages 199–212

Lemaire-Potteau E., Vallve X., Pavlov D., Papazov G., N. van der Borg, J.-F. Sarrau ABLE project: development of an advanced lead-acid storage system for autonomous PV installations, *Power Sources*, 162 (2006), pp. 884–892

Maclay J.D., Brouwer J., Samuelson G.S., Dynamic analyses of regenerative fuel cell power for potential use in renewable residential applications, *Hydrogen Energy*, 31 (2006), pp. 994–1009

Mahmoud M.M., On the storage batteries in solar electric power systems and development of an algorithm for determining their ampere-hour capacity, *Elect Power Syst Res*, 71 (2004), pp. 85–99

Marija D. Ilic, John Zaborszky Superconducting Machines: Energy Storage, Encyclopedia of Materials*: Science and Technology* (Second Edition), 2001, pp. 8941-8943 C.A. Luongo

Ross J.N., Markvart T., He W., Modelling battery storage regulation for a stand-alone photovoltaic system, *Sol Energy*, 69 (2000), pp. 181–190

Watson, J., Co-provision in sustainable energy systems: the case of micro-generation, *Energy Policy*, 32 (2004), pp. 1981–1990.

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.*

Objectives:

1. Developing of methodology for design PV-battery system which has to support the broader use of renewable energy.

2. Optimizing the dispatching of PV system for medium and low voltage grid system operators.

3. Optimizing the battery system characteristics and capacity which can prepare the energy sector for their broader scale use.

Outcomes:

Developing an algorithm for optimal sizing of battery systems for grid connected differently situated PV power plants. This algorithm will support reducing the PV fluctuations and will optimize demand response opportunities for medium and low voltage systems

Fundamental scientific and technical value

The project proposal is very much in line with the priorities of Republic of Bulgaria in the Bulgarian strategy for Scientific development 2020. It also goes along with the EU 2020 goals related to the climate and energy. There are a number of priorities in the National Scientific Strategy on which the project will have an impact, like for example:

In the priority field „Energy, energy efficiency and transport. Development of green and eco-technologies", the project envisages a realization of innovative energy solution, which will allow a yearly energy feed of customers with renewable energy having very good demand response parameters. The grid connected PV battery system will work with very good efficiency and will have a positive effect on reducing fossil fuels.

In the priority field „Health, quality of life, biotechnologies and eco-food" the project envisages a melioration of the standard of living and the microclimate for the energy users.

In the priority field „New materials and technologies" the project envisages a follow-up construction of contemporary high technology platform for scientific research in the field of energy storage devices. At present, Technical University of Sofia is applying to get an EU Funding to construct the lab.

The project proposal is in line with the Bulgarian National Road Map for scientific infrastructure, which is focused on the research in the field of renewable energy sources and energy efficiency.

The initiatives of the European Commission for smart cities and smart grids give the direction for the energy development in the future – by developing systems for maximum utilization of renewable energy and its on-site usage.

On the basis of the results a student and engineering manual will be prepared to train students and engineers in utility companies to design, operate and maintain, grid connected PV-baterry systems. This will improve life quality of the utility customers by improving the quality of supplied energy, as the same time large broader implementation of the PV systems will lead the decrease the environment pollution.

The Use of PV-battery systems will megliorate the managing and dispaching of the grid conected renewble energy sources.

The necessary infrastructure and software have to simulate battery systems and grid connected differently situated PV power plants and customer loads. I believe that PLATOS: Planing Tool for Optimized Storage is extremely useful. The idea is to use PLATOS to determine how many differently sized and differently situated PV battery power plants have to be installed to best fit demand in a branch.

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.

Intelligent energy is all about managing energy more efficiently than ever before.Demand for energy keeps growing worldwide, and the use of it must become more sustainable. At the same time there is a growing need for an expansion and modernisation of the existing energy infrastructure.

This will require a systematic optimisation of the energy system, and today's grids will gradually transform into interactive, transparent and environment-friendly smart grids, often interconnecting regions.

The technology and know-how in the field of intelligent energy are renowned internationally. Consultants and anufacturing companies offer state-of-the-art advice and products within energy management systems, power transmission, distribution solutions and power electronics.

Balancing supply and demand

According to the trends of ending fossil fuels and European directives consumers have to become self-sufficient in energy by means of sustainable power and balance a grid with fluctuating energy supply. Moving toward fossil independence means that renewable energy sources such as sun,become ever more important. Therefore the energy system of the future must be intelligent and able to communicate with consumers to constantly balance supply and demand. Demand will be increasingly adapted to suit power generation – unlike today, where it is the other way round. Well-designed PV-battery systems can help utilisation of intelligent energy. This study can help utilities better understand feeder performance if distributed PV-battery systems is added to a given circuit or circuits. The research will identify potential back-feed, voltage drop, or voltage flicker issues associated with operation of the proposed distributed PV generation.

Power flow studies also help utilities identify key asset management issues such as increases in regulator or capacitor switching operations, which could result from adding distributed PV.

Distributed PV-battery can offer utility benefits

Despite the challenges of integration, distributed PV can offer benefits to the utility that include reducing pick demands and system losses, delayed capital investments for capacity improvements, and improved control on PV fluctuation.

The addition of distributed PV-battery system to the electric system can allow greater penetration across the electric power system.

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.

My works demands mainly usage of a specific software. I consider very important to be able to work with PLATOS: Planning Tool for Optimized Storage.

Time-sequence power flow study approach

Generator simulator which allows to perform a time-sequence power flow study to help assess and address PV battery integration issues to a given circuit or circuits. I need data to includes 24- and 8,760-hour simulations using hourly load and PV output data. It also must includes one-minute simulations to evaluate power quality and system control issues. Together, these simulations will help to identify potential of PV battery system to cover PV fluctuations and better to fit demand response when proposed distributed PV generations work.

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.

There is a project run by Technical University of Sofia, whose aim is to build a pilot PV hydrogen, battery hybrid system. The project “ Renovation of the Laboratory Base for Applied Purposes of TU Sofia by Equipping the Pilot Hybrid Energy Installation” is financed under priority axis 1.2.04 of OP “Competitiveness” /European Regional Development Fund/.

The purpose of my research work in Kema will be to develop a model to design a PV battery system. On the basis of these results, I will be able to advice the Technical University of Sofia, what kind of batteries to use. The outcomes of my research will be also applied by electrical distribution companies.

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.

- Technical articles for 2013 TU Sofia /Sozopol/ conference on Energy distribution and efficiency
- Dissemination article for “Energy” (Bulgarian journal for recent trends in the energy field)
- Technical paper for international conferences/symposia organized by IEEE, such as SmartGridComm, CDC, ISIE, INDIN, and and by IFAC.
- Manual, to be used for conduction of laboratory exercises, trainings and practical exercises for students, Ph.D. researchers and practitioners that are going to construct and exploit grid connected PV-battery systems.

Time schedule (about ½ page)

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

Activity/month	*0*	*1*	*2*	*3*	*4*
State of the art	*done*				
Requirement analysis		*X*			
Designing		*X*	*X*		
Dissemination				*X*	*X*

starting date may be at the beginning of May 2013

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.

Vesselin Chobanov is an assistant professor at “Electrical and Electronic Engineering” Department at the Technical University - Sofia, Faculty of Engineering and Pedagogy - Sliven. He is teaching the following courses: “Electrical networks and systems” and “Renewable energy sources and environmental protection”.

Chobanov’s research interests are in the field of decentralized renewable energy sources and their impact on the energy efficiency of electricity networks. He did a specialization on these issues in ADEME laboratory in the Université de Corse and the Laboratoire d'Electrotechnique et d'Electronique de Puissance de Lille. Technical University of Delft – Netherlands. He has published articles and reports in a number of Bulgarian and international journals. Some of his studies have found a practical implementation in "Eduardo Miroglio" EAD.

Chobanov participated in a number of scientific conferences and projects, the most important among them being: (First international symposium on environment identities and Mediterranean area, ISEIM-2006, IEEE France section, Corte-Ajaccio, 2006; Third International Conference on Ecological Vehicles & Renewable Energies, EVER, Monaco, 2008; Advanced Electromechanical Motion Systems & Electric Drives Joint Symposium, Electromotion 2009, Lille, France24th European Photovoltaic Solar Energy Conference and Exhibition, Hamburg,Germany 2010; The 24th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems ECOS-Serbia 2011.). In 2010 he was involved as a lecturer in “Sunflower“ project, financed by the “Intelligent Energy Program”, 2010.

His research interest in intelligent networks (Smart Grid) is a professional challenge, which was provoked by the fact that in the EU and in particular in Bulgaria, the traditional electric networks have to be upgraded to "smart" networks, which is part of the EU strategy for energy efficiency. This is a very relevant, new and innovative issue, having a concrete practical value for the national economy. The development of „smart" grids, which are inherently green and energy saving technologies, will lead to hundreds of millions savings in euro, due to the more efficient use of the electricity consumed.

The experience of KEMA which has a serious impact on the research in this field, can successfully be used in Bulgaria for the development of "smart" networks to the National Electricity Company and the individual distribution companies.

1. Nedeltcheva S., P.Poggi, M.Muselli, G.Notton, **V.Chobanov**. Modeling and simulation of a photovoltaic - wind turbine - fuel cells hybrid system. OPEM-2005, Sozopol, 18-21.09.2005.
2. Nedeltcheva S., P.Poggi, G.Notton, M.Muselli and **V.Chobanov**, Examination of the Influence of the Dispersed Generation in the Distribution Networks for Medium Voltage, First international symposium on environment identities and Mediterranean area, ISEIM-2006, IEEE France section, CD ISEIM-2006, ISBN 1-4244-0232-8, IEEE Catalog Number 06EX13229C, Paper V2s431, Corte-Ajaccio, 10-13.07.2006, p.246-249
3. Nedeltcheva S., P.Poggi, **V. Chobanov**, Methodology for an Investment Project Having Optimal Economic Indicators in the Field of Decentralized Energy Production, Third

International Conference on Ecological Vehicles & Renewable Energies, EVER, Monaco, 27-30.03.2008.

4. Nedeltcheva S., G. Notton, P. Poggi, K. Stoyanova, **V.Chobanov**, Reliability of electrical distribution network with decentralized production, Advanced Electromechanical Motion Systems & Electric Drives Joint Symposium, Electromotion 2009, Lille, France ISBN: 978-1-4244-5150-0, p.1-4
5. Nedelcheva S., **V.Chobanov**, Multicriteria optimization of the compensated reactive power in the integrated branches of PV power plants, 24th European Photovoltaic Solar Energy Conference and Exhibition, EU PVSEC Proceedings, ISBN 3-936338-25-6, Hamburg,Germany p.3762-3765
6. Nedelcheva S., **V.Chobanov,** N.Dimitrov, Examination of asymmetrical conditions in low-voltage distribution grid with distributed generation, 24th European Photovoltaic Solar Energy Conference and Exhibition, EU PVSEC Proceedings, ISBN 3-936338-25-6, Hamburg,Germany p.3766-3769
7. Nedelcheva S., **Chobanov V**., Energy Effectiveness of Photovoltaic Modules, The 24th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems ECOS-2011, Book of proceedings, ISBN 978-86-6055-016-5, Novi sad, Serbia, p.3358-3367
8. **Chobanov V**., What is profitable dispersed generation?, The 24th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems ECOS-2011**,** Book of proceedings, ISBN 978-86-6055-016-5, Novi sad, Serbia, p.1785-1793