DERri
Distributed Energy Resources
Research Infrastructures

ANNEX 2: TEMPLATE FOR PROPOSAL UNDER DERRI

User-Project Proposal:

Use-Project Acronym	FORENTER
User-Project Title	Generation and load FORecasting for ENergy management in the TERtiary sector
Main-scientific field	Automation and control
Specific-Discipline	Energy management systems

Lead User of the Proposing Team:

Name	Luca Ferrarini
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Nationality	Italy
Organization name, web site and address	Politecnico di Milano – Dipartimento di Elettronica e Informazione http://www.dei.polimi.it/index.php?&idlang=eng Via Ponzio 34/5 Milan - Italy
Activity type and legal status* of Organization	Higher Education Institute
Position in Organization	Full 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	Domenico Bianco
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Nationality	Italy
Organization name, web site and address	Politecnico di Milano – www.polimi.it
Activity type and legal status* of Organization	Higher Education Institute
Position in Organization	Student

Name	Marco Pernice
Phone	0223993615
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Nationality	Italy
Organization name, web site and address	Politecnico di Milano – Dipartimento di Elettronica e Informazione http://www.dei.polimi.it/index.php?&idlang=eng

	Via Ponzio 34/5 Milan - Italy
Activity type and legal status* of Organization	Higher Education Institute
Position in Organization	Researcher

* 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	30/09/2010
Re-submission	YES_____ NO___X___
Proposed Host TA Facility	
Starting date (proposed)	November 2010

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 aim of the project is the design and development of an innovative ICT-based low-cost infrastructure for electrical energy management, monitoring and remote load, generation & storage control for the tertiary field. To get the most advantage from energy management it is necessary to provide a platform which will be interoperable with building automation systems and will supply several functionalities, such as communication with energy distributor/retailer and users, HVAC control, and management of loads, on-site micro-generation, and possible local energy storage units. In this way a global efficiency could be achieved, while 'active customers' will become "active nodes" of the energy network that might also provide services to the network (power modulation) and to the market (reduce energy price volatility).

In order to improve energy management, forecast for local energy generation and consumption is included. Forecasting may help to balance production and consumption, setting the (hourly) net power exchange with the network.

The expected outcomes of the project are: identification and development of main function for load, local (micro) generation and storage management; integration of generation/load forecast into energy management; estimation of possible energy and economic savings.

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.

Electricity consumption in the tertiary sector is growing – more than 2% per year is expected in EU countries over the next 15 years. According to recent EU directions, refurbishment interventions of the existing building should be associated with improvement of energy management systems. In fact, the largest cost-effective savings potential lies in the residential (households) and commercial buildings sector (tertiary sector), where the full potential is now estimated to be around 27% and 30% of energy use, respectively [1]. In commercial buildings, improved energy management systems offer the greatest opportunity.

Diffusion of Distributed Generation (DG) especially from renewable resources (RES) is adding new possibilities to the interaction between LV (and MV) customers and the network. On the other side, DG diffusion could involve possible criticalities for distribution networks [2].

In several EU Countries, combination of market liberalization and DG diffusion is promoting innovative schemes: in Italy, for example, starting from 2011 photovoltaic plants (PV) with a "predictable exchange profile" will get a +20% incentive for their energy production [3].

The EC Recommendation C(2009) 7604 "asks for a closer cooperation between the ICT sector and building and construction sector to improve the environmental and energy performance of new and existing buildings, and to address the existing barriers to the wider use of ICT tools and their relevant applications".

In order to reach these aims and to achieve a global efficiency in tertiary employ, a complex strategy including not only energy and gas prices but also their specific exploitation, customer preferences and external parameters as seasonal temperature change is required. This strategy may better monitor and control energy performance of buildings, where local generation must be included [4, 5], especially because it could imply a power flow towards the network instead of consumption. In addition, local storage units could improve flexibility in energy management, while their economic benefits should be still identified.

References

List relevant References

[1] COMMUNICATION FROM THE COMMISSION Action Plan for Energy Efficiency: Realising the Potential, COM(2006)545 final

[2] Luca Ferrarini and Carlo Veber (editors), "Modeling, Control, Simulation and Diagnosis of Complex Industrial and Energy Systems", ISA series on Distributed Industrial Automation 2008, Product ISBN/ID: 978-1-934394-90-8. www.isa.org/modeling.

[3] Decree 129/2010 published 24th August 2010, art 10.

[4] Luca Ferrarini, Marco Pernice, "Modeling and Control of a Thermal Energy System in a Building Automation Scenario" INDIN 2009, Cardiff, 24-26 June, 2009.

[5] M. de Chirico, S. Esposito, L. Ferrarini, P. Magni, C. Montecucco, S. F. Nicolodi, S. Radaelli, "Bringing efficiency through energy management:The UTILTEC Project", ANIPLA2006, 1st ANIPLA International Congress on Methodologies for Emerging Technologies in Automation, 13-15 Nov. 2006, Roma, Italy, paper T115.

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 of the project are designing, prototyping and testing of basic advanced estimation algorithm, to be included in more complex energy management system.

In particular, the project aims at prototyping an innovative solution based on ICT technologies able to perform advanced local (at the end-user side) energy management and to interact with the network in order to optimize energy consumption and balancing production, consumption and storage. Electrical energy will be the main focus, although thermal energy will be of interest, in that thermal energy production and consumption are often not separable from electrical energy.

The application field will be that of the tertiary field. Tertiary buildings, both for living, working shopping or entertainment, represent an interesting study case, both for their energy consumption and size, which make it feasible a relevant level of optimization, before moving to the urban level.

The basic stones for the proposed infrastructure are monitoring and remote load, generation & storage control. These include many other specific functionalities as communication with energy distributor/retailer and users, HVAC control, and management of loads, on-site micro-generation, and possible local energy storage units. In this way a global efficiency could be achieved.

Another pillar of the architecture is the prototypical design of adequate forecast / estimation algorithms for both local energy generation and consumption. Forecasting may help to balance production and consumption, setting the (hourly) net power exchange with the network.

The project is composed by the following phases:

- Analysis in the field of market available ICT solutions (1MM)
- Requirement analysis and detailed specification (1MM)
- Designing and protopyting of basic advanced estimation algorithm (3 MM)
- Testing in laboratory equipment (1MM)
- Analysis of the testing and simulation activities (1MM)
- Dissemination (2MM)

Many are the outcomes of the project. The main ones are:

- identification and development of main functions for load, local (micro) generation and storage management;
- prototyping of basic generation/load forecast / estimation algorithms;
- integration of generation/load forecast into energy management;
- quantitative estimation of possible energy and economic savings;

- tailoring practical solutions for the tertiary field.

The project is built upon previous work by the proposers. It can be estimated that the project will be more focused on investigation and prototyping, which pave the way to many future works on the same line.

The main drawbacks are mainly related to the possible "small" gain in energy efficiency, small reliability of prediction models, high cost of the overall infrastructure. However, many studies and projects have been carried out that show that the trend is definitely positive in the possibility to achieve significant gains with cheap ICT technologies. A risk of the project can be related to the unavailability of the market to accept such a framework, for many different reasons. Again, even in this case, many research and technology transfer projects as well as real experiments in the field show that the potential interested users are numerous all over Europe, and that some "virtuous" cycle has already been initiated among provider of technologies, service providers, engineering companies and users, especially in those countries where the political class is extremely sensitive to the environmental problems.

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.

Many are the research activities in the specification and proposal of innovate control for end-user electrical / thermal energy consumption. However, there is still margin of gaining energy savings. For example the Italian project "Energetica Mente" (www.energetica-mente.biz) shows that up to 20% of total gas consumption can be reached just with a suitable innovative control policy applied to condensing boilers for apartment buildings.

Definitely more innovative is the integration of production management with consumption management, the electrical energy management with the thermal energy management, the integration of estimation / prediction with management and control.

All the above are the innovative targets of the FORENTER project.

In addition, tertiary buildings, because of their energy consumption and characteristics, represent a good starting point where integrated approach may be applied. Storage units may improve energy management in order to get a desired profile for net energy exchange with the network.

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.

To carry out the experimental activity, the TA should be equipped with adequate sensors and a data acquisition & storage system - allowing to compare estimated values with real generation and absorption.

To effectively test the various proposed algorithms, it is necessary to rely on a 'smart customer'

facility (in case, a simpler "domotic house" could suffice) equipped with loads, local generation (PV plant) and possibly a storage unit, controlled by an automation system where proposed functions may be installed. Main information regarding the facility should be communicated before the test phase, in order to set correctly all environmental parameters used by the algorithm itself.

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 proposed project is in synergy with the following projects

- UTILTEC. The aim is the design and development of an innovative ICT-based low-cost infrastructure for electrical energy management, monitoring and remote load control for public utilities, residential customers and tertiary field.
- ENERTEC. The aim is the design and development of a management system for any kind of energy sources and exploitations at customer side, including distributed generation, demand response, load control, and safety issues
- ENERGETICA MENTE (http://www.energetica-mente.biz/pagine/pagina.aspx?&L=IT). The aim is to design and implement an ICT solution for the management and control of the centralised heating system of apartment buildings endowed with distributed accounting system for heat consumption.

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 2011 ANIPLA conference on Energy efficiency (Italian Association for Automation) www.anipla.it
- Dissemination article for "Energia e Automazione" (italian magazine Automation and Energy, published by ANIPLA)
- Technical paper for international conference/symposium organized by IEEE and IFAC

Time schedule (about ½ page)

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

Target stat date (M1): November 2010

Activity/Month	**1**	**2**	**3**	**4**	**5**	**6**
State-of-the-art						
Requirement analysis						

Designing							
Testing							
Dissemination							

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.

The proposing team is made up of:

- full professor: Luca Ferrarini
- student: Domenico Bianco
- researcher: Marco Pernice

Luca Ferrarini

Luca Ferrarini received the "Laurea" Degree in Electrical Engineering (summa cum laude) from the Politecnico di Milano, Milan, Italy, in 1988, and a post-Laurea degree in Industrial Process Control, from the Master School CEFRIEL in 1990. In 1994 he was a visiting researcher in Kyoto University, Kyoto, Japan. Since 1990, he has been with the Dipartimento di Elettronica e Informazione, Politecnico di Milano, where he is full professor since 2004, teaching courses on industrial automation and discrete event systems.

He is author of 7 patents (5 Italian and 2 European) in the design and testing of industrial automation systems field, for large complex production plants. He is senior member of IEEE and collaborates with IEC, ISA, IFAC and ANIPLA (Associazione Nazionale Italiana Per L'Automazione), the Italian National Association for Automation of which he was national president in 2003 and 2004. He's author of around 160 scientific contributions, including 4 books, 4 book chapters, 25 journal papers. He has been tutor of 4 PhD students, and a hundredth of Laurea degree final projects (tesi). His research interests include discrete-event systems and Petri nets; control system development methodology for industrial distributed control and automation systems; modeling, simulation and control of manufacturing processes; monitoring and control of electro-thermal energy systems.

Domenico Bianco

He received the Bsc degree in Automation Sngineering from the Politecnico di Milano, Milano, Italy, in 2008. Currently, he is a student of Automation Engineering in the Dipartimento di Elettronica e Informazione (DEI) at Politecnico di Milano, Milano, Italy. In the meantime, he was an Erasmus student at Universidad Carlos III de Madrid (Escuela Politecnica Superior). He also worked as a research intern in the Laboratory for Proactive Technologies in Tallin, Estonia. His task was to enhance a simulation of mobile vehicles implemented in Mathworks Matlab Simulink/Staleflow to include local decision logic and mediated interactions between the vehicles and remote data sources.

Marco Pernice

He received the degree in Automation Engineering from the Politecnico di Milano, Milano, Italy, in 2009. His final dissertation project is on "Technical-economic simulations of thermal and electric generators for final users", consisting in a software package for automatic design and calculation of thermo-electric high efficiency generators. Currently, he is an assistant professor in

the Dipartimento di Elettronica e Informazione (DEI) at Politecnico di Milano, Milano, Italy, focusing on didactic activities and research project of energy management.

Publications

Luca Ferrarini, Marco Pernice, "Modeling and Control of a Thermal Energy System in a Building Automation Scenario" INDIN 2009, Cardiff, 24-26 June, 2009.

M. de Chirico, S. Esposito, L. Ferrarini, P. Magni, C. Montecucco, S. F. Nicolodi, S. Radaelli, "Bringing efficiency through energy management:The UTILTEC Project", ANIPLA2006, 1st ANIPLA International Congress on Methodologies for Emerging Technologies in Automation, 13-15 Nov. 2006, Roma, Italy,paper T115.

Luca Ferrarini and Carlo Veber (editors), "Modeling, Control, Simulation and Diagnosis of Complex Industrial and Energy Systems", ISA series on Distributed Industrial Automation 2008, Product ISBN/ID: 978-1-934394-90-8. www.isa.org/modeling.

L. Ferrarini, J. Carneiro, "Preventing thermal overloads in transmission circuits via model predictive control" , IEEE Transactions on Control System Technology, to be published, 2010.

L. Ferrarini, J. Carneiro, "Reliability Analysis of Power System based on Generalized Stochastic Petri Nets" PMAPS2008, IEEE International Conference on Probabilistic Methods Applied to Power System, Puerto Rico, 25-29 May 2008.