User-Project Proposal:

User-Project Acronym	SMOOTHING
User-Project Title	**S**mart **M**anagement **O**f FESS c**O**upled **T**o a p**H**otovolta**I**c power pla**N**t in a micro**G**rid
Main-scientific field	Renewable energy
Specific-Discipline	Energy storage, photovoltaic energy, automatic control

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Activity type and legal status* of Organization	(1) – Public research organization
Position in Organization	University 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)

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Activity type and legal status* of Organization	Public research organization
Position in Organization	Environmental Engineer

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Activity type and legal status* of Organization	Public research organization
Position in Organization	University 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:

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Activity type and legal status* of Organization	Public research organization
Position in Organization	Teacher who has passed aggregation (Electrical Engineering)

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Activity type and legal status* of Organization	(1) – Public research organization
Position in Organization	PhD student

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Activity type and legal status* of Organization	(1) – Public research organization
Position in Organization	Engineer

Additional Users in the Proposing Team:

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Activity type and legal status* of Organization	(1) – Public research organization
Position in Organization	Doctor

Date of submission	29/02/2012
Re-submission	YES_____ NO___x____
Proposed Host TA Facility	DER Low-Voltage Test Facility (DER-TF) of RSE in Milan (Italy) and/or TECNALIA_LAB in Derio (Spain)
Starting date (proposed)	15/10/2012

Summary of proposed research (about ½ page)

In a context where renewable energies from both wind and solar energy have low predictability, low controllability and strong variability, their massive integration into power systems may cause instabilities for these grids.

The regulatory framework in the different countries around the world is evolving fastly and we could see, in the next months/years, the adoption of different technical constraints that impose to smooth and/or control the production. These probable regulatory frameworks tend to encourage the integration of Energy storage systems (ESS) into power systems at the power plant location in order to provide such a control of the production.

First studies on the subject have shown a strong interest for powerful energy storage systems with a discharge duration between 1 hour and 15 min for coupling an energy storage system with renewable energy sources such as PV or Wind. Among the different ESS, the flywheel technology appears to be well scaled for such an application.

In the same time, an ESS at the power plant location may offer the opportunity to use it for ancillary services. Among the different services, frequency/voltage regulation and power quality services appear to be interesting in terms of potential revenue and may be consider as such.

Flywheel Energy Storage Systems (FESS) are competitive with chemical batteries in applications like transportation or improving power quality, which involve many charge-discharge cycles and little in the way of long-term storage. Particularly, FESS can be used to smooth the photovoltaic energy production. Photovoltaic energy can vary a lot on an island, where the weather can change very quickly. A smart grid, called PAGLIA ORBA, with photovoltaic and wind generation, and with real loads (offices and accommodations), is on the way to be built in Corsica (Ajaccio). This research will allow preparing the ground to this PAGLIA ORBA smart grid, in order to manage it with control algorithms (in islanded mode and in grid-connected mode).

In the proposed work, first, we would like to measure the different key criteria that define the performance of a flywheel such as power, energy, effficiency in different conditions. We would also get the opportunity to measure transient phenomena for this technology. The objective of these tests is to then be able to validate two kind of flywheel modeling: a load flow model and a transient model of the performance of the flywheel technology. Then, we would like to measure the performance of the ESS for three applications:

1) Smooth the PV production (by using forecasting of photovoltaic energy production)
2) Voltage/Frequency regulation (islanded mode), and PQ control (in grid-connected mode)
3) Mixed application: PV smoothing and frequency/voltage regulation and PQ control

The tests of the different applications will be the opportunity to check the validity of the model build on the first testing period in real condition of operation. The results will also be used for the last adjustment of the model.

State-of-the-Art (about 1 ½ page)

With large integration of photovoltaic energy in a grid of an island such as Corsica, stability of the electrical network becomes an important issue. Some researches were made on one hand about the coupling of photovoltaic power plant and storage systems, and on the other hand about the forecasting of photovoltaic energy production.

The possibility of the photovoltaic energy smoothing was examined by an Asian researcher group [2]. They used Electric Double Layer Capacitor (EDLC) and Flywheel system to "suppress the power variation".

In the context of microgrid, in this paper [1], the stability of a microgrid was studied in islanded mode and grid-connected mode with a flywheel. According to the mode, either PQ control (fixed active and reactive power control) or Droop control or Frequency/Voltage are used. Simulation results show how the flywheel uses PQ control only when the MicroGrid is operated in grid-connected mode. During islanded mode, the control scheme of the flywheel has to be switched from PQ control to Droop control or Frequency/Voltage.

Forecasting researches have been done both in photovoltaic production side [3][4][5][6][7][8][9][10][9] and load side [11].

References

[1] X. Wu, Y. Zhang, A. Arulampalam, et N. Jenkins, « *Electrical Stability of Large Scale Integration of Micro Generation Into Low Voltage Grids* », International Journal of Distributed energy Resources, vol. 1, n°. 4, p. 279–298, 2005.

[2] N. Hasegawa, K. Fujimoto, T. Matsuyama, T. Ichikawa, K. Yukita, Y. Goto, et K. Ichiyanagi, « *Suppression of power variation for PV using flywheel and EDLC* », in Transmission & Distribution Conference & Exposition: Asia and Pacific, 2009, 2009, p. 1–4.

[3] C. Paoli, C. Voyant, M. Muselli, et M.-L. Nivet, « *Forecasting of preprocessed daily solar radiation time series using neural networks* », Solar Energy, vol. 84, n°. 12, p. 2146–2160, déc. 2010.

[4] C. Voyant, « *Prédiction de séries temporelles de rayonnement solaire global et de production d'énergie photovoltaïque à partir de réseaux de neurones artificiels* », 2011.

[5] C. Voyant, M. Muselli, C. Paoli, et M.-L. Nivet, « *Optimization of an artificial neural network dedicated to the multivariate forecasting of daily global radiation* », Energy, vol. 36, n°. 1, p. 348–359, janv. 2011.

[6] C. Voyant, M. Muselli, C. Paoli, M. L. Nivet, P. Poggi, et P. Haurant, « *Predictability of PV power grid performance on insular sites without weather stations: use of artificial neural networks* », arXiv:1001.2097, janv. 2010.

[7] C. Paoli, C. Voyant, M. Muselli, et M. L. Nivet, « *Solar radiation forecasting using ad-hoc time series preprocessing and neural networks* », in Proceedings of the 5th international conference on Emerging intelligent computing technology and applications, 2009, p. 898–907.

[8] A. Rodler, « *Sélection et hybridation de modèles pour la prévision de la ressource solaire* », Université de Corse, Ajaccio, Rapport de stage, sept. 2011.

[9] P. Lauret, E. Fock, R. N. Randrianarivony, et J.-F. Manicom-Ramsamy, « *Bayesian neural network approach to short time load forecasting* », Energy Conversion and Management, vol. 49, n°. 5, p. 1156 – 1166, 2008.

[10] Shu Fan, Yuan-Kang Wu, Wei-Jen Lee, et Ching-Yin Lee, « *Comparative study on load forecasting technologies for different geographical distributed loads* », in 2011 IEEE Power

and Energy Society General Meeting, 2011, p. 1–8.

[11] T. M. Peng, N. F. Hubele, et G. G. Karady, « Advancement in the application of neural networks for short-term load forecasting », Power Systems, IEEE Transactions on, vol. 7, n°. 1, p. 250 –257, févr. 1992.

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

The study would be focused on the smoothing of photovoltaic energy by using only FESS in grid-connected mode, and in islanded mode.

In the case of the islanded mode, there will be a fixed controllable load (resistive – inductive load), according to the photovoltaic production and the time in the day.

The objectives are:
1. Validation of FESS models. Simulations will be compared with the real values
2. Determine the minimum technical specifications of the FESS to smooth the photovoltaic energy production (according to the size of the photovoltaic power plant).
3. Implementation of different algorithms to smooth the photovoltaic energy production, and comparison of the results according to the used methods (fuzzy logic…)
4. Check the validity of flywheel technology for PV smoothing.
5. Implementation of algorithms to decide when the FESS must be used all the time during the day - Implementation of algorithms to make a decision when the FESS must be started to smooth photovoltaic energy production. Different forecasting methods will be used (neuronal network…)
6. If we can use flywheels of two TA infrastructures, the results will be compared
7. Integration of the flywheel technology on the PAGLIA ORBA microgrid platform

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

Most of Flywheel Energy Storage Systems (FESS) has non-negligible auto-discharging time. If the FESS works continually, auto-discharging time causes energy losses when photovoltaic energy does not vary more than a determined threshold. The originality and innovation work consist to make algorithms, which determines when the FESS must be started to be charged, when it must be discharged and when it must be stopped.

The study would be focused on the smoothing of photovoltaic energy by using only FESS in grid-connected mode, and in islanded mode (in this case there will be a fixed load, according to the photovoltaic production and the time in the day). This system is friendly environmental, in comparison with electrochemical batteries.

These researches would be a first step to control the storage systems in the smart – grid of PAGLIA ORBA. It would allow us to make (if necessary) some modifications in the architecture of this microgrid. It also would be a first step to make a tool that decides, according to the forecasted variability of photovoltaic energy, when we have to use electrochemical batteries and when we have to use electromechanical storage systems (there will be different electrochemical batteries in the PAGLIA ORBA platform such as ZEBRA battery, flow batteries...).

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

The TA infrastructures that we would like to use:
- DER Low-Voltage Test Facility (DER-TF) of RSE in Milan (Italy)
- TECNALIA_LAB in Derio (Spain)

Both hosts have a flywheel in their laboratory.

Synergy with ongoing research (about ½ page)

In Reunion Island, a company is working with the University of Reunion Island to do a decision-making tool (Soleka,
http://www.reuniwatt.com/index.php?option=com_content&view=article&id=5&Itemid=5&lang=en)
This tool will enable to predict the next day's photovoltaic power plants' production in order to inform   the   electricity   network   administrator   and   the   producers.
In our work, the prediction will be on the producer side in order to manage the storage systems in the microgrid as good as possible. In this way, the life time of the storage systems will be improved.

Our project will complete the project of this company by using a flywheel (on producer side).

Dissemination – Exploitation of results (about ½ page)

We will participate to colloquiums and conferences in 2012 and 2013. The results of the tests performed in the infrastructure would be disseminated in articles (Science Direct and IEEE).

Time schedule (about ½ page)

Actions	April 2012				May 2012				June 2012				July 2012				August 2012				September 2012				October 2012				November 2012				December 2012			
Phase 1: Preparation	W 14	W 15	W 16	W 17	W 18	W 19	W 20	W 21	W 22	W 23	W 24	W 25	W 26	W 27	W 28	W 29	W 30	W 31	W 32	W 33	W 34	W 35	W 36	W 37	W 38	W 39	W 40	W 41	W 42	W 43	W 44	W 45	W 46	W 47	W 48	W 49
Modeling of the systems	<= From March																																			
Implementation of algorithms																																				
Simulations																																				
Phase 2: experiments																																				
Experiments on the DERri infrastructures																																				
Phase 3: Publications																																				
Writing of the publications																																				
Publications, conferences and Colloquiums																															Until 2013 =>					

Starting Date: October 08th 2012

Duration of experiments: 3 weeks

Description of the proposing team (as long as needed)

The University of Corsica develops skills in the field of renewable energies and energy storage. Participating in this project allows the university to complete and develop smart-grid (PAGLIA ORBA), which will be used in Ajaccio-Vignola. This platform is intended as a test platform and test equipment developed by industry, and participate in this program is in its strategy. The solution "flywheel" is a track that should be explored.

A 560-kWp grid-connected photovoltaic power plant was built in the site of the University in Ajaccio (Vignola). This PV power plant is coupled with a 100-kW electrolyser (EL) and a 200-kW fuel cell (FC), which is connected to the island grid (for the moment the powers of the present system are respectively 25 kW and 100 kW). The system has and a 3500-kWh hydrogen-based storage system. The name of the project is MYRTE (Mission hYdrogen Renewable for the inTegration to the Electrical network). The MYRTE project is the world largest Hydrogen-based energy management system coupled to a photovoltaic field.

This project has as goals the decrease of daily load peaks on the case of an island electric network by using a PV/FC/EL renewable energy system, the storage and valorization of generated heat and high efficiency and durability, independent of air quality.

The target applications are:
- Renewable energy sources management: peak shaving, load leveling, optimization of production forecast
- Grid stabilization services: secondary and tertiary energy reserves.

Prof. Philippe POGGI (46 years old), role in the project: project manager Philippe POGGI is Professor in energy at the University of Corsica (France). He is PhD on Renewable in Energy from the University of Corsica (France) since 1995. His special fields of interest include solar radiation, wind potential, renewable energy systems grid connected and hybrid systems study. He works on coupling renewable energy sources and hydrogen production and fuel cells. He manages a R&D platform on this subject: renewable energy sources coupling with storage (hydrogen, battery ion-Lithium, redox, fly wheel…) and smart-grid with electrical mobility. He is also in charge of the masters Ecological Engineering and Energy Systems and Renewable Energies of the University of Corsica.

<u>List of publications of Prof. Philippe POGGI:</u>

[POG49]. Potential grid-impact of electric vehicle recharge: A case study of commuting in Corsica Island, France

C. Grosjean, O. Wiss, M. Perrin, P. Poggi,

Journal of Power Sources (under submission)

[POG48]. Assessment of world lithium resources and consequences of their geographic distribution on the expected development of the electric vehicle industry

C. Grosjean, P. Herrera Miranda, M. Perrin, P. Poggi

Renewable & Sustainable Energy Reviews, <u>Volume 16, Issue 3</u>, Pages 1735–1744, April 2012

[POG47]. An M-Rice wind speed frequency distribution

R. Baile, JF. Muzy, P. Poggi

Wind Energy, February 2011

[POG46]. Short term forecasting of surface layer wind speed using a continuous random cascade model.

R. Baïle, J.F. Muzy, P. Poggi.

Wind Energy, 14-1, January 2011

[POG45]. Load and weather profile, and time simulation impacts for the PEPITE PV/H2 project

C. Darras, S. Sailler, C. Thibault, M. Muselli, P. Poggi, J.C. Hoguet, S. Melscoet, E. Pinton, S. Grehant, F. Gailly, C. Turpin, S. Astier, G. Fontès

International Journal of Hydrogen, October 2010

[POG44]. Intermittency of surface layer wind velocity series in the mesoscale range

J.Muzy, R. Baïle, P. Poggi

Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 81 (5), 2010

[POG43]. Sizing of photovoltaic system coupled with hydrogen/oxygen storage based on the ORIENTE model

C. Darras, S. Sailler, C. Thibault, M. Muselli, P. Poggi, J.C. Hoguet, S. Melscoet, E. Pinton, S. Grehant, F. Gailly, C. Turpin S. Astier, G. Fontès

International Journal of Hydrogen, July 2010

[POG42]. Sizing of a PV/H2 Hybrid System to supply peak loads on an isolated electrical grid – A case study in Corsica Island (France)

P.Poggi, C.Cristofari, J.L. Canaletti, C.Darras, M.Muselli

Transaction in Hybrid Renewable Energy, Global Journal on Technology and Optimisation, Accepted March 2009

[POG41]. Modeling and Simulating of a PV/H2 Hybrid System for Reducing Load Peaks on an Electrical Grid

C.Darras, M.Muselli, P.Poggi, C.Cristofari, X.Le Pivert

ECS Transactions, Fuel Cell Seminar - Vol. 12, Issue 1, p 609-621, June 2008

[POG40]. Uncovering latent singularities from multifractal scaling laws in mixed asymptotic regime. Application to turbulence.
J.F. Muzy, E. Bacry, R. Baile, P. Poggi,
Europhysics Letters, (82), June 2008

[POG39]. Integration of wind-generating units into the Corsican electrical grid: determination of the maximal Integration rate from a reliability analysis based on a stochastic process.
P.Poggi, M.Muselli, C.Cristofari.
Int. J. of Nuclear Governance, Economy and Ecology, Vol.2, Issue 1, 63-81, 2008

[POG38]. Modelling and Simulating of an Energetic Complex System Constituted by a Photovoltaic Array, a Wind Turbine, an Electrolyzer and Fuel Cells
P.Poggi, M.Muselli, C.Cristofari, C.Darras, P.Serre-Combe, F.Le Naour,
ECS Transactions - Fuel Cell Seminar, Applications: Residential" Vol. 5, March 2007

[POG37]. Calculation of the polycrystalline PV module temperature using a simple method of energy balance
M. Mattei, G.Notton, C.Cristofari, M.Muselli, P.Poggi.
Renewable Energy, 31-4, 553–567, 2006

[POG36]. Performance evaluation of various hourly slope irradiation models using Mediterranean experimental data of Ajaccio
G.Notton, P.Poggi, C.Cristofari.
Energy Conversion and Management, 47-2, 147–173, 2006.

[POG35]. Predicting hourly solar irradiations on inclined surfaces based on the horizontal measurements: Performances of the association of well-known mathematical models
G.Notton, P.Poggi, C.Cristofari
Energy Conversion and Management, 47, 13-14, 1816-1829, 2006.
International communications with selection committee

[POG34]. Alimentation électrique d'un site isolé à partir d'un générateur photovoltaïque associé à un tandem électrolyseur/pile à combustible (batterie H_2/O_2)
F. Gailly, C. Turpin, S. Astier, M. Plantevin, Y. David, J.C. Hoguet, E. Pinton, C. Darras, C. Thibault, P. Poggi
Conférence Electrotechnique du Futur EF'2011, Belfort, December 2011

[POG33]. Safety cost of a large scale hydrogen system for photovoltaic energy regulation
G.Hu, J.Dubois, P.Poggi, F.Montignac, P.Serre-Combe, M.Muselli, J.Hoguet, B.Vesy, F.Verbecke
4ème International Conference on Hydrogen Safety, San Francisco, September 2011

[POG32]. Modelling of a PV/H2 Hybrid System with ORIENTE Software: Case of a micro-grid Isolated Site on La Réunion Island.'

C.Thibault, C. Darras, M.Muselli, G.Hu, P. Poggi

Hydrogen Fuel Cells 2011: International Conference and Exhibition .Vancouver, May 2011

[POG31]. Assessment of world lithium resources and consequence on the expected development of electric vehicle industryssica

C. Grosjean, P.Herrera Miranda*,* M. Perrin, P. Poggi

Conférence Kraftwerk Batterie, , Aix-La-Chapelle, Germany, March 2011

[POG30]. Hydrogen Energy Systems Integration For Flexible Energy Storage
F. Verbecke, JC. Hoguet, S. Besse, M. Muselli, P. Poggi

First International Conference for Sustainable Energy Storage, Belfast, Irllande, February 2011

[POG29]. Solar atlas implementation and planning of PV system off-grid electrification in Djibouti
B. Pillot, M. Muselli, P.Poggi

25th European Photovoltaic Solar Energy Conference and Exhibition & 5th World Conference on Photovoltaic, Valencia, Spain, September 2010

[POG28]. Load and weather profile impacts for the PEPITE PV/H2 project
C. Darras, C. Thibault, M. Muselli, P. Poggi, JC. Hoguet, S. Melscoet, E. Pinton, F. Gailly, C. Turpin, S. Astier, G. Fontes

25th European Photovoltaic Solar Energy Conference and Exhibition & 5th World Conference on Photovoltaic, Valencia, Spain, September 2010

[POG27]. Sizing of photovoltaic system coupled with hydrogen storage based on the ORIENTE model

C. Darras, S. Sailler, C. Thibault, M. Muselli, P. Poggi, J.C. Hoguet, S. Besse , E. Pinton, S. Grehant, F. Gailly 1,2, C. Turpin 1,2, S. Astier1,2, G. Fontès1,2

18th World Hydrogen Energy Conference 2010, Essen, Germany, May 16th-21th, 2010

[POG26]. MYRTE: High Performance Technological Platform for Hydrogen Energy Storage for Grid connected

 C. Darras, C. Thibault, P. Poggi, M. Muselli, J.C. Hoguet, S. Melscoet, E. Pinton, F. Gailly, C. Turpin, S. Astier, G. Fontès

 2nd International Conference on Hydrogen Energy, 2010, May 6th-9th, 2010

[POG25]. Impact of electric vehicle charging on an interconnected island power grid: case study of commuting in Corsica
C. Grosjean, O. Wiss, M. Perrin, P. Poggi

5th International Conference and Exhibition on Ecological Vehicles and Renewable Energies, March 25th-28th, 2010, Monte-Carlo, Monaco

[POG24]. Intermittency of surface layer wind speed fluctuations in the mesoscale range. Application to short term forecasting

R.Baile, JF.Muzy, P.Poggi

World Renewable Energy Conference, May 2009, Bangkok, Thailand

[POG23]. Corsica R&D Platform Myrte coupling photovoltaic plant – hydrogen and fuel cells

P.Poggi, G.Hû, J.C.Hoguet, S. Besse

3rd International Workshop on Hydrogen, October 28th-31st, 2009, Rabat, Morocco

[POG22]. Hybrid hydrogen systems for renewable and decentralised energy production: Helion recent developments

J.C.Hoguet, S. Besse, V. Chaudrona, P.Poggi, G.Hû

3rd International Workshop on Hydrogen, October 28th-31st, 2009, Rabat, Morocco

[POG21]. Predictability of PV power grid performance on insular sites without weather stations: use of artificial neural networks

C.Voyant, M.Muselli, C.Paoli, M-L.Nivet, P.Poggi

24th European Photovoltaic Solar Energy Conference and Exhibition, Hambourg, Germany, 21st-24th September 2009

[POG20]. ORIENTE: a new numerical sizing software for hybrid system

S. Sailler, C. Darras, M. Muselli, P. Poggi, E.Pinton, J-C.Hoguet, S.Besse

24th European Photovoltaic Solar Energy Conference and Exhibition, Hambourg, Germany, September 21st-24th, 2009

[POG19]. PV/H2 Hybrid System Sizing: The Pepite Project

C. Darras, S. Sailler, M. Muselli, P. Poggi, E.Pinton, J-C.Hoguet, S.Besse

24th European Photovoltaic Solar Energy Conference and Exhibition, Hambourg, Germany, September 21st-24th, 2009

[POG18]. Corsica R&D Platform Myrte Coupling Photovoltaic Plant – Hydrogen and Fuel Cells

P.Poggi, G.Hû, J-D Reber, J-C Hoguet

International Conference on Hydoren and Islands, Brac, Croatia, October 22nd-24th, 2008

[POG17]. New Approach For Hybrid PV/H2 System Sizing

C. Darras, P. Poggi, M. Muselli

23th European Photovoltaic Solar Energy Conference and Exhibition, Valencia, Spain, September 5th-10th, 2008.

[POG16]. Sizing of A PV/H2 Hybrid System To Supply Peak Loads On An Isolated Electrical Grid. A Case Study In Corsica Island (France)

C.Darras, M.Muselli, P.Poggi

3rd International Symposium on Environment, Athens, Grèce, May 22nd-25th, 2008

[POG15]. Performance Comparison between Two Copolymer Hybrid PV/T Collectors

C.Cristofari, G.Notton, P.Poggi, M.Mattei, S. Boddaert

ISES Solar World Congres 2007, Beijing, September 2007

[POG14]. Evaluation de l'Amelioration de la Photoconversion par Refroidissement Actif en utilisant une approche Matlab/Simulink
S.Boddaert, R.Morlot, C.Menezo, P.Poggi, C.Cristofari
JITH, ALBI, August 2007

[POG13]. Simulation Model of Finite Differences Concerning Copolymer Hybrid PV/T Collector
C.Cristofari, G.Notton, P.Poggi
IASTED International Conference, ASIAPES, Thailande, April 2nd-4th, 2007

[POG12]. Modelisation, Optimisation and 4 Years Performance Study of a Photovoltaic System Connected to an Islander Electrical Grid
P.Poggi, M.Muselli, C.Cristofari, G.Notton
IASTED International Conference, ASIAPES, Thailand, April 2nd-4th, 2007

[POG11]. Data reconciliation and gross error detection of the generator of a wind turbine
O.Bennouna, N.Heraud, O.Mallassé, P. Poggi, G.Notton,
DEWI Congress, Germany, 2006

[POG10]. Lessons learned of five years of performance of a photovoltaic system connected to an island electrical grid
P.Poggi, M.Muselli, C.Cristofari, G.Notton, N.Heraud.
21th European Photovoltaic Solar Energy Conference and Exhibition, Dresden, Germany, September 4th-9th, 2006.

[POG9]. Modelling and simulating of an energetical complex system constituted by a Photovoltaic Array, a Wind Turbine, an Electrolyzer and Fuel Cells.
P.Poggi, M.Muselli, C.Cristofari
IASTED International Conference, Bostwana, September 11th-13th, 2006

[POG8]. Thermal Modelling of a Photovoltaic Module.
C.Cristofari, P.Poggi, G.Notton, M.Muselli.
IASTED International Conference, Bostwana, September 11th-13th, 2006

[POG7]. Hybrid system photovoltaic array – wind turbine – electrolyzer – fuel cells modelling and simulating
P.Poggi, M.Muselli, C.Cristofari, C.Darras, P.Serre-Combe, F.LeNaour
Fuel Cells Seminar, Honolulu, United States, December 1st-4th, 2006

[POG6]. Gross error detection of the generator of a wind turbine
O.Bennouna, N.Heraud, C.Cristofari, M. Muselli, G.Notton, P. Poggi
IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio,France, July 10th-13th, 2006.

[POG5]. Copolymer hybrid photovoltaic/thermal solar collector for water heating

C.Cristofari, G.Notton, P.Poggi, M.Muselli, N.Heraud

IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio,France, July 10th-13th, 2006.

[POG4]. Coupling hydro and wind electricity production by water-pumping storage

P. Poggi, M. Muselli, C.Cristofari, G.Notton, N.Heraud

IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio, France, July 10th-13th, 2006.

[POG3]. Examination of the influence of the dispersed generation in the distribution networks for medium voltage

S. Nedeltcheva, P.Poggi, G. Notton, M. Muselli, V.Tchobanov.

IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio,France, July 10th-13th, 2006.

[POG2]. Hourly solar irradiations estimation: from horizontal measurements to inclined data.

G.Notton, C.Cristofari, M. Muselli, P. Poggi, N.Heraud.

IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio, France, July 10th-13th, 2006.

[POG1]. Wind farms territorial integration in Corsica: Methodology and case study in Bonifacio.
P. Oberti, M. Muselli, P. Poggi

IEEE Congress, First International Symposium on Environment, identities in Mediterranean Area, Corte-Ajaccio, France, July 10th-13th, 2006.

Prof. Marc MUSELLI (41 years old), Role in the project: Scientific project manager responsible for prediction renewable energy resources
Professor Marc MUSELLI received his Ph.D. degree from the university of Corsica, France, in 1997. He is currently a researcher at the G.PERI Scientific Research center in Ajaccio (CNRS UMR 6134), in the project "Renewable Energy". The research topics concern neural networks for solar energy forecast and photovoltaic production, smart-grids, system modeling, passive radiative transfer for water production. He is the author or co-author of 52 publications in international journals and 96 conferences papers.

List of publication of Prof. Marc MUSELLI:

[MUS54]. Numerical Weather Prediction (NWP) and hybrid ARMA/ANN model to predict global radiation

C.Voyant, M.Muselli, C.Paoli, ML.Nivet

Accepted à Energy, January 2nd, 2012 (2012)

[MUS53]. Very large dew and rain collector in the Kutch area (Gujarat, India)

G. Sharan, O. Clus, S. Singh, M. Muselli*, D. Beysens

Journal of Hydrology, Vol.405, pp.171-181, DOI : 10.1016/j.jhydrol.2011.05.019 (2011)

[MUS52]. Dew, fog, rain as supplementary sources of water in south-western Morocco

I. Lekouch, M. Muselli, B. Kabbachi, J. Ouazzani, I. Melnytchouk-Milimouk, D. Beysens

Energy, Vol.36, pp.2257-2265, doi:10.1016/j.energy.2010.03.017 (2011)

[MUS51]. Multicriteria selection aiding of photovoltaic plants on farming fields in Corsica Island: a real case study in the ELECTRE outranking framework

P.Haurant, P.Oberti, M.Muselli*

Energy Policy, 39, pp.676–688, doi:10.1016/j.enpol.2010.10.040 (2011)

[MUS50]. Optimization of an artificial neural network dedicated to the multivariate forecasting of daily global radiation

C.Voyant, M.Muselli*, C.Paoli, ML.Nivet

Energy, 36, pp. 348-359, DOI : 10.1016/j.energy.2010.10.032 (2011)

[MUS49]. Forecasting of preprocessed daily solar radiation time series using neural networks

C. Paoli, C.Voyant, M.Muselli*, M.L.Nivet

Solar Energy, 84, pp.2146-2160, doi:10.1016/j.solener.2010.08.011 (2010)

[MUS48]. Load and weather profile, and time simulation impacts for the PEPITE PV/H2 project

C. Darras, C. Thibault, M. Muselli*, P. Poggi, S. Melscoet, J.C.Hoguet, E. Pinton, F. Gailly, C. Turpin

International Journal of Hydrogen Energy, 35, pp. 10138-10147, doi:10.1016/j.ijhydene.2010.07.106 (2010)

[MUS47]. Sizing of a PV/H2 hybrid system to supply Peak loads on an isolated electrical grid – A case study in Corsica Island (France)

P.Poggi, C.Cristofari, J.L. Canaletti, C.Darras, M.Muselli

Global Journal on Technology and Optimization, Transaction in Hybrid Renewable Energy, Vol.1, pp.24-29, ISSN 1985-9406 (2010)

[MUS46]. Sizing of photovoltaic system coupled with hydrogen/oxygen storage based on the ORIENTE model.

C. Darras, S. Sailler, C. Thibault, M. Muselli, P. Poggi, J.C. Hoguet, S. Melscoet, E. Pinton, S. Grehant, F. Gailly , C. Turpin, S. Astier, G. Fontès
International Journal of Hydrogen Energy, 35, pp. 3322-3332, DOI:10.1016/j.ijhydene.2010.01.060 (2010)

[MUS45]. Passive Cooling For Air-Conditioning Energy Savings with New Radiative Low-Cost Coatings.
M. Muselli
Energy and Buildings, 42, pp. 945-954, doi : 10.1016/j.enbuild.2010.01.006 (2010)

[MUS44]. Comparative chemical analysis of dew and rain water (Zadar, Croatia)
I.Lekouch, M.Mileta, M.Muselli, I.Mylimouk, V.Sojat, B.Kabbachi, D.Beysens
Atmospheric Research, Vol.95, N°2-3, pp. 224-234, d oi: 10.1016/j.atmosres.2009.10.002 (2010)

[MUS43]. Comparison of Various Radiation-cooled Dew Condensers by Computational Fluid Dynamic
O. Clus, J. Ouazzani, M. Muselli, V. Nikolayev, G. Sharan, D. Beysens
Desalination, 249, pp.707-712, DOI : 10.1016/j.desal.2009.01.033 (2009)

[MUS42]. Dew and Rain Water Collection in South Croatia.
D.Beysens, I.Lekouch, M.Mileta, I.Milimouk, M.Muselli
International Journal of Environmental Science and Engineering, Vol.1, N°2, pp.64-70 (2009)

[MUS41]. Condenseurs Radiatifs de Rosée.
D.Beysens, I.Mylimuk, M.Muselli
Techniques de l'Ingénieur - Génie Energétique, IN101 - 4, pp. 1-11 (2009)

[MUS40]. Dew And Rain Water Collection In The Dalmatian Coast, Croatia
M. Muselli, D. Beysens, M. Mileta, I. Milimouk
Atmospheric Research, Vol.92, N°4, pp. 455-463, doi :10.1016/j.atmosres.2009.01.004 (2009)

[MUS39]. University of Corsica – UMR CNRS 6134: research activities in renewable energy field. International Scientific Journal for Alternative Energy and Ecology (ISJAEE), Vol. 6, .pp. 249-257.
G.Notton, C.Cristofari, J.L.Canaletti, P.Poggi, M.Muselli, N.Heraud. (2008).

[MUS38]. Study of dew water collection in humid tropical islands
O. Clus, P. Ortega, M. Muselli, I. Milimouk, D. Beysens
Journal of Hydrology, Vol. 361, Iss 1-2, pp. 159-171 (2008)

[MUS37]. Modeling and Simulating Of A Pv/H2 Hybrid System For Reducing Load Peaks On An Electrical Grid
C. Darras, M. Muselli , P. Poggi, C.Cristofari, X.Le Pivert

ECS Transactions - 2007 Fuel Cell Seminar & Exposition, Vol.12, Iss 1, "3D - Residential Scale", pp. 609-621 (2008)

[MUS36]. *Integration of Wind-generating units into the Corsican electrical grid : determination of the maximal integration rate from a reliability analysis based on a stochastic process.*

P. Poggi, M. Muselli, C. Cristofari

International Journal Nuclear Governance, Economy and Ecology, 2-1, pp.63-81 (2008)

[MUS35]. *Modeling and Simulating of an Energetic Complex System Constituted by a Photovoltaic Array, a Wind Turbine, an Electrolyzer and Fuel Cells*

P. Poggi, M. Muselli, C. Cristofari, C. Darras, P. Serre-Combe, and F. Le Naour

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[MUS34]. *Collecting dew to improve water resources: the D.E.W. project in Biševo (Croatia).*

D. Beysens, M. Mileta, I. Milimouk, M. Muselli, O. Clus

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[MUS33]. *Is Dew Water Potable? Chemical and Biological Analyses of Dew Water in Ajaccio (Corsica Island, France).*

M.Muselli, D.Beysens, E.Soyeux

Journal of Environmental Quality, 35, pp.1812-1817 (2006)

[MUS32]. *Comments on "The moisture from the air as water resource in arid region: hopes, doubts and facts"*

D.Beysens, I.Milimouk, V.Nikolayev, S.Berkowicz, M.Muselli, B.Heusinkveld, A.F.G.Jacobs

Journal of Arid Environments, Vol.67, Iss 2, pp. 343-352 (2006)

[MUS31]. *Chemical and Bacterial Characteristics of Dew and Rain Water in an Urban Coastal Area (Bordeaux, France).*

D. Beysens, C. Ohayon, M. Muselli, O. Clus

Atmospheric Environment, Vol.40, Iss 20, pp. 3710-3723 (2006)

[MUS30]. *Application of Passive Radiative Cooling for Dew Condensation*

D.Beysens, M.Muselli, I.Milimouk, C.Ohayon, S.Berkowicz, E.Soyeux, M.Mileta, P.Ortega

Energy, Vol. 31, Iss 13, pp. 2303-2315 (2006)

[MUS29]. *A Comparative Study of Two Large Radiative Dew Water Condensers.*

M.Muselli, D.Beysens, I.Milimouk

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[MUS28]. *Calculation of the polycrystalline PV module temperature using a simple method of*

energy balance.

M.Mattei, G.Notton, C.Cristofari, M.Muselli, P.Poggi.

Renewable Energy Vol. 31, Issue 4, pp.553-567 (2006)

[MUS27]. Passive Radiative Condensers To Extract Water From Air.

D.Beysens, M.Muselli, I.Milimouk, C.Ohayon, S.Berkowicz, E.Soyeux, M.Mileta, P.Ortega

Sustainable Development of Energy, Water and Environment Systems, Vol.II, pp.471-480 (2005) ISBN: 953-6313-69-3

[MUS26]. Measurement and Modeling of Dew in Island, Coastal and Alpine Areas.

D.Beysens, M.Muselli, V.Nikolayev, R.Narhe, I.Milimouk

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[MUS25]. Passive Radiative Condensers to Extract Water from Air

D. Beysens, M. Muselli, I. Milimouk, C. Ohayon, S. Berkowicz, E. Soyeux, M. Mileta, P. Ortega,

Bull. of the Croatian Meteorological Society, Hrvatski meteorološki èasopis 39, 59-69 (2004)

[MUS24]. Intégration de fermes éoliennes dans un réseau électrique non interconnecté : aspect statistique.

 P.Poggi, M.Muselli, G.Notton

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[MUS23]. Xibridni sistemi ot vazobnovimi iztochnici zavtonomno proizvodstvo na elektroenergia - Systèmes hybrides à sources renouvelables pour production décentralisée dans les sites isolés

G.Notton; M. Muselli; C.Cristofari; P.Poggi; S. Nedeltcheva

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[MUS22]. Calculation on an Hourly Basis of Solar Diffuse Irradiations from Global Data for Horizontal Surfaces in Ajaccio.

G.Notton, C. Cristofari, M. Muselli, P. Poggi

Energy Conversion and Management, Vol. 45, Iss 18-19, pp.2849-2866 (2004).

[MUS21]. Forecasting And Simulating Wind Speed In Corsica By Using An Autoregressive Model.

P.Poggi, M.Muselli, G.Notton, C.Cristofari, A.Louche

Energy Conversion and Management, Vol. 44, Iss 20, pp. 3177-3196 (2003).

[MUS20]. Using Radiative Cooling To Condense Atmospheric Vapor: A Study To Improve Water Yield.

D.Beysens, I.Milimouk, V.Nikolayev, M.Muselli, J.Marcillat

Journal of Hydrology, Vol. 276, pp.1-11 (2003).

[MUS19]. Dew Water Collector For Potable Water in Ajaccio (Corsica Island, France)

M.Muselli, D.Beysens, J.Marcillat, I.Milimouk, T.Nilsson, A.Louche
Atmospheric Research, Vol. 64, pp. 297-312 (2002).

[MUS18]. Calculation of Solar Irradiances Profiles for Hourly Data in view of Energy Systems Behaviour Simulation

G.Notton, C.Cristofari, P.Poggi, M.Muselli
Renewable Energy, Vol. 27, N°1, pp. 123-142 (2002).

[MUS17]. Wind Electrical Supply System : Behaviour Simulation and Sizing Optimization

G.Notton, C.Cristofari, P.Poggi, M.Muselli
Wind Energy, Vol.4, pp.43-59 (2001)

[MUS16]. First Order Markov Chain Model for Generating Synthetic 'Typical Days' Series of Global Irradiation in Order to Design PV Stand Alone Systems

M.Muselli, P.Poggi, G.Notton, A.Louche
Energy Conversion and Management, Vol.42, N°6, pp.675-687 (2001)

[MUS15]. Water Production in an Ancient Sarcophagus at Arles–s–Tech (France)

D.Beysens, M.Muselli, J-P.Ferrari, A.Junca
Atmospheric Research, Vol.57, N°3, pp. 201-212 (2001)

[MUS14]. Decentralized Wind Energy Systems Providing Small Electrical Loads in Remote Areas

G.Notton, M.Muselli, P.Poggi, A.Louche
International Journal of Energy Research, Vol.25, pp.141-164 (2001)

[MUS13]. Grid-Connected Rooftop PV systems for Reducing Voltage Drops at the End of the Feeder – A Case Study in Corsica Island

V.Acquaviva, P.Poggi, M.Muselli, A.Louche
Energy, Vol.25, pp.741-756 (2000)

[MUS12]. Stochastic Study of Hourly Total Solar Radiation in Corsica Using a Markov Model

P.Poggi, G.Notton, M.Muselli, A.Louche
International Journal of Climatology, Vol.20, N°14, pp. 1843-1860 (2000)

[MUS11]. Classification of Typical Meteorological Days from Global Irradiation Records and Comparison between Two Mediterranean Coastal Sites in Corsica Island

M.Muselli, P.Poggi, G.Notton, A.Louche
Energy Conversion and Management, Vol.41, N°10, pp. 1043-1063 (2000)

[MUS10]. PV-Hybrid Power Systems Sizing Incorporating Battery Storage: An Analysis via Simulation Calculations

M.Muselli, G.Notton, P.Poggi, A.Louche

Renewable Energy, Vol.20, N°1, pp. 1-7 (2000)

[MUS9]. Computer Aided Analysis of the Integration of Renewable Energy Systems in Remote Areas using a Geographical Information System.

M.Muselli, G.Notton, P.Poggi, A.Louche

Applied Energy, Vol.63, N°3, pp. 141-160 (1999)

[MUS8]. Design of Hybrid-Photovoltaic Power Generator, with Optimization of Energy Management

M.Muselli, G.Notton, A.Louche

Solar Energy, Vol.65, N°3, pp. 143-157 (1999)

[MUS7]. Utilisation Rationnelle de l'Énergie et Énergies Renouvelables, des alliés incontestables : Application à une Production Décentralisée d'Électricité Photovoltaïque

G.Notton, M.Muselli

Revue de l'Énergie, N°498, pp. 300-310 (1998)

[MUS6]. Improved Procedure for Stand-Alone Photovoltaic Systems Sizing Using METEOSAT Satellite Images

M.Muselli, P.Poggi, G.Notton, A.Louche

Solar Energy, Vol.62, N°6, pp. 429-444 (1998)

[MUS5]. Costing of a Stand-Alone Photovoltaic System

G.Notton, M.Muselli, P.Poggi

Energy, Vol.23, N°4, pp. 289-308 (1998)

[MUS4]. Utilization of METEOSAT Satellite-Derived Radiation Data for Integration of Autonomous Photovoltaic Solar Energy Systems in Remote Areas

M.Muselli, G.Notton, J.L.Canaletti, A.Louche

Energy Conversion and Management, Vol.39, N°1/2, pp . 1-19 (1998)

[MUS3]. Two Estimation Methods For Monthly Mean Hourly Total Irradiation on Tilted Surfaces From Monthly Mean Daily Horizontal Irradiation Solar Radiation Data of Ajaccio, Corsica

G.Notton, M.Muselli, A.Louche

Solar Energy, Vol.57, N°2, pp. 141-153 (1996)

[MUS2]. Autonomous Photovoltaic Systems : Influence of some Parameters on the Sizing : Simulation Time-Step, Input and Output Power Profile

G.Notton, M.Muselli, P.Poggi, A.Louche

Renewable Energy, Vol.7, N°4, pp. 353-369 (1996)

[MUS1]. Autonomous Hybrid Photovoltaic Power Plant using a Back-Up Generator : A Case Study in a Mediterranean Island

G.Notton, M.Muselli, A.Louche

Renewable Energy, Vol.7, N°4, pp. 371-391 (1996)

Vincent FERRERI,   Role in the project: Technical project manager responsible for electrical engineering

Vincent Ferreri has passed aggregation (Electrical Engineering). He is teaching at the University of Corsica and at the high school of Monteroso in Bastia (Electrotechnics, Electric machines and automatic control). He is in charge of practical works. He also teaches courses of mathematics and physics.

Gaëlle HU, Role in the project: in charge of safety measures

Mrs Gaëlle HU is an engineer graduated from the University of Corsica. She was project manager in the MYRTE project. She has elaborated safety instructions in the MYRTE platform.

List of conferences:

Présentation des filières de stockage associées aux énergies renouvelables
P.Poggi, G.Hû, Conférence Invitée « Energie
Durable dans les PTOM » Bruxelles, Belgique, 25--26 Septembre 2008

Corsica R&D Platform Myrte Coupling Photovoltaic Plant - Hydrogen and Fuel Cells
P.Poggi, G.Hû, J--D. Reber, J--C Hoguet, International Conference on Hydrogen and Islands, Brac, Croatia, 22--24 Octobre 2008

Présentation de la politique énergétique française, Gaëlle HU, Conference at the University of Munich, Germany 28 Octobre 2008

Corsica R&D Platform Myrte coupling photovoltaic plant   hydrogen and fuel cells, P.Poggi, G.Hû, J.C.Hoguet, S. Besse, 3ème --31 Octobre 2009
Hybrid hydrogen systems for renewable and decentralised energy production: Helion recent developments,
J.C.Hoguet, S. Besse, V. Cha--31 Octobre 2009, Rabat, Morocco

Modelling of a PV/H2 Hybrid System with ORIENTE Software: Case of a micro--grid Isolated Site on La Réunion Island, C.
Thibault, C. Darras, M. Muselli, P. Poggi, G. Hû, Hydrogen + Fuel Cells 2011: International Conference and Exhibition, Canada

The Safety impact on the costs of a large scale Hydrogen system for Intermittent Energy Storage into an electrical Grid
Hû G., Dubois J., Poggi P., Montignac F., Serre--Combe P., Muselli M., Hoguet JC., Vesy B., Verbecke F., ICHS4 2011, San Francisco

Cédric ABBEZZOT (27 years old), Role in the project: experimenter

Mr Cédric ABBEZZOT is a PhD student and an engineer graduated from the Institut National des Sciences Appliquées (INSA) in Toulouse in 2008. He is an Automatic control Engineer specialized in renewable energy field. He has some experiences in modeling and simulation with Matlab/Simulink and Labview. He has been in Sweden as an Erasmus student, where he was in a project team, whose the goal was to model and simulate a turbo car engine. He did his final engineering study project in Continental VDO in Regensburg (Germany). He was in a Hardware-in-the-Loop team, and the aims of his project were to couple two Real time PCs by using reflective memory and to compare two engine models in Simulink and AMESim.

He is doing his research activities in energy storage systems coupled to photovoltaic array, which is connected to an island grid. He will prepare and do the experiments in the project.

Guillaume PIGELET (25 years old), Role in the project: experimenter

Guillaume PIGELET is a mechanical and energy engineer. He is working on the projects MYRTE and PAGLIA ORBA. He is in charge of the instrumentation and the installation of sensors on these platforms. He is also in charge of the smart grid algorithms. He gives also some courses in metrology and electrotechnics at the University of Corsica. He will prepare and do the experiments in the project.

Christophe THIBAULT, Role in the project: experimenter

Graduated from the University of Montpellier in France. He got his PhD in 2004 at the European Institute of Membranes in Montpellier on the use of Raman spectroscopy for the characterization of the ionic transport within polymer membranes which are usually used for desalination or fuel cell applications. He also got a great experience on batteries after working in collaboration between the University of Montpellier (Laboratoire de Physico-chimie de la Matière Condensée) and SAFT company on the life cycle of Ni(OH)2 electrodes in 2004. Concerned with environmental challenge for the future, he worked at the FC-Lab in Belfort (France), fully specialized on Fuel Cells, on corrosion phenomena on the surface of bipolar plates for Fuel Cell

applications. He also joined for one year the laboratory of the Professor Juin-Yih Lai in Chungli, Taiwan (R&D) Centre for Membrane Technology, CYCU), with the aim of studying the transfer phenomena of methanol through a membrane for Direct Methanol Fuel Cell applications. Desirous to bring his experience for new projects and acquire more skills, he is working at the University of Corsica (UMR 6134 SPE, Centre de Vignola, France) on hybrid system ReS-H2 projects (PEPITE, MYRTE) for applications in the case of grid-connected or isolated sites.

He will prepare and do the experiments in the project.

List of publication of Chrispohe THIBAULT:

[THI7]. Smoothing of the PV electricity production by means of an electrolyser and a Fuel Cell

Christophe Darras, Christophe Thibault, Guillaume Pigelet, Emmanuel Vinciguerra, Marc Muselli, and Philippe Poggi –. International Journal of Hydrogen Energy (to be published)

[THI6]. Isolated Site feeds by PV/H2 hybrid solution. Case of Mafate islet in La Réunion Island
Christophe Thibault, Christophe Darras, Marc Muselli, Philippe Poggi, and Harry Boyer (to be published)

[THI5]. Smoothing of the Solar production by means of ReS system
Christophe Darras, Christophe Thibault, M. Muselli, P. Poggi (to be published)

[THI4]. Investigation on methanol crossover through Nafion membrane for Direct Methanol Fuel Cell
Christophe Thibault, Da-Ming Wang, J-Y Lai - First results about methanol distribution (under preparation)

[THI3]. Sizing of photovoltaic system coupled with hydrogen/oxygen storage based on the Oriente model
Christophe Darras, Marc Muselli, Christophe Thibault, Philippe Poggi — International Journal of Hydrogen Energy, Volume 35, Issue 8, April 2010, Pages 3322-3332

[THI2]. Load and weath Res-H2 profile impact based on the Oriente model
Christophe Darras, Marc Muselli, Christophe Thibault, Philippe Poggi – Solar Energy, International Journal of Hydrogen Energy, Volume 35, Issue 19, October 2010, Pages 10138-10147

[THI1]. Confocal Raman micro-spectroscopy and electrochemical investigation of anion transport through ion-exchange membranes.

Christophe Thibault, Patrice Huguet, Philippe Sistat, Gérald Pourcelly - Desalination 149 (2002) 429-433