

ETRERA Project: an Europe –Tunisia cooperation in S&T transfer

G. Squadrito⁽¹⁾, A. Nicita⁽¹⁾, R. Chtourou⁽²⁾, B. Auvity⁽³⁾, A. Soraci⁽⁴⁾.

⁽¹⁾ CNR-ITAE, Institute for Advanced Energy Technologies “N. Giordano”, Via Salita S. Lucia sopra Contesse, 5 – Messina, ITALY - gaetano.squadrito@itae.cnr.it

⁽²⁾ CRTEn, Research and Technology Center of Energy, Technopole of Borj Cedria, BP 95 – Hammam Lif – TUNISIA

⁽³⁾ Polytechnic School of Nantes University, Quai de Tourville 1 - Nantes, FRANCE

⁽⁴⁾ InnovaBIC SpA, Via Acireale ZIR – Messina, ITALY.

Abstract

The project “Empowering Tunisian Renewable Energy Research Activities” (ETRERA) was funded by European Community-FP7 under REGPOT-2009-2 Action, an action finalized to empower the research cooperation in innovation between the European and the Mediterranean countries.

ETRERA project was aimed at the creation of a research network on renewable energy sources (RES), hydrogen (H₂) and fuel cell (FC) technologies involving as primary actors the Tunisian “Research and Technology Center of Energy” (CRTEn), and three European entities: 1) Institute for Advanced Energy Technologies “N. Giordano” of the National Research Council of Italy (CNR-ITAE); 2) Polytechnic School of Nantes University (Polytech Nantes), France; 3) Innova Business Innovation Centre (InnovaBIC), Italy. Starting from this nucleus we like to develop an Euro-Mediterranean network dedicated to RES, H₂ and FC technologies. ETRERA started in 2010 and was completed in June 2013. It was centred on fuel cell technology, because up to 2010 there was not a laboratory dedicated to FC in Tunisia.

Project partners have been involved in coordinated activities to reinforce the research structure of CRTEn. A new research lab dedicated to research on polymer electrolyte fuel cells (PEFCs) was built up at CRTEn. The recruitment of new researchers was carried out to increase the research capacities and the human potential of CRTEn. The experience of CNR-ITAE and Polytech Nantes on FC and hydrogen technologies, spanning from material preparation to the system integration, was shared by exchange of researchers, the organization of seminars and starting collaborative research activities on PEFCs. Dissemination was a very important aspect of the project, and it was carried out through a set of actions aimed at increasing the visibility of the partners and related research activities to obtain a wide dissemination of the project results to scientific community and European and Tunisian industries. The Innova BIC’s experience in communication was used for this purpose.

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*Along the way we encountered political and social problems (Arab spring) and the necessity to merge also different administrative approaches.
We report here our experience, the obtained results, lesson learnt and our proposition for the future.*

Keywords: Euro-Mediterranean scientific cooperation, Renewable Energy Sources, Hydrogen, Polymer Electrolyte Fuel Cells, FP7, Technology Transfer Local Industries.

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1. Introduction

The availability of adequate energy provisions is a key factor for the economic development of any country, industrialised or emerging one. This drives an increasing world energy demand in front of limited traditional energy sources availability, and the necessity to limit the carbon dioxide (CO₂) emission. Today, a large part of world countries have initiated policies aiming at the reduction of CO₂ emissions and the introduction of renewable energies sources. These are intended to introduce a virtuous cycle that should lead to an increase of energy consumption efficiency and a reduction of the pollution emissions to meet the global issue of a “sustainable development”.

Due to the global importance of this issue, collaboration policies between countries play a fundamental aspect, especially to develop and spread knowledge and technologies related to efficient energy production and consumption, renewable energies sources exploitation, waste treatment and recycling.

European Union policies strongly support research collaborations of European countries with neighbourhood countries. These efforts were enforced in 2004 as consequence of the European Union enlargement that opened new opportunities to deepen existing relations.

Among the Mediterranean neighbourhood countries, Tunisia established diplomatic relations with EU in 1976 and along the years signed with EU collaboration agreements covering different activity sectors, including transports, environment and energy [1-3].

Tunisia has limited conventional energy resources (gas and petroleum) and its demand for energy, mainly electricity, is rising sharply due to its economic growth. This aspect is highlighted by the continuous increase of the energy balance deficit recorded since 2001, as results of a growing demand and stagnating supply [4]. To contrast this trend, in the 10th and 11th Economic Development Plan, ambitious objectives to enforce the policy on rational use of energy was stated, and Tunisian Government launched national projects aimed at improving the utilization of solar heat and photovoltaic, and increasing the industrial energy efficiency. The social

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disorder related to the so called “Arab Spring” in 2011 and the consequent changes in administration, slowed down the energy programs actuation, not the increase of energy demand.

In this contest, the research on energy technologies plays a fundamental role in supporting the energetic policies and is asked to transfer to local industries the related technological knowhow. For this reason, Tunisia launched the so-called 'national system of innovation', planning twelve new science and technology parks by the year 2010. Six have actually being implemented. One of these, Borj-Cedria Science and Technology Park, the first one that has been implemented, host three research centres working in environmental sector: Research and Technology Centre of Energy (CRTE_n), Water Resources and Technology Centre (CERT_e) and Biotechnology Centre (CBBC). To boost their research activities these centres have looked for collaboration with foreign centres operating in the same research fields.

Empowering Tunisian Renewable Energy Research Activities (ETRERA), presented in this paper, is a project working in this direction. ETRERA (<http://www.etrera.eu>) is funded under FP7-REGPOT-2009-2 action of the European Commission. The EU action is finalized to empower the research cooperation in innovation between the European countries and the Mediterranean countries. The ETRERA project was aimed at the creation of a research network on renewable energies involving as primary actors the Tunisian “Research and Technology Centre of Energy” (CRTE_n), and three European entities: the Institute for Advanced Energy Technologies “N. Giordano” (CNR-ITAE) – Italy; the Polytechnic School of Nantes University (Polytech Nantes) – France; the Business Innovation Centre (InnovaBIC) - Italy.

The project started on January 1st 2010, with a 36 month work plan. In carrying out of the project activities, the partners have faced several difficulties. First of all, the so called “Arab spring” started in Tunisia between December 2010 and January 2011, and propagated to other Arab countries along 2011. Although Tunisia was able to solve the question in few months by changing their leadership, this event and its consequences caused a series of difficulties that obliged the project to be prolonged of 6 months, up to June 2013. By increasing our efforts we was able to maintain alive the project, without any stop, but a slowing down of the activities was needed to deal with this difficult political and economic period.

In our paper we present all the project history, the obtained results and the lesson learnt, introducing also our ideas for the future.

2. Project plan

The project has been based on the Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis of CRTE_n. This has permitted to draw a Scientific & Technological state of the art of the centre. It has pointed out CRTE_n main research activities and S&T needs in terms of know-how, expertises, technologies and missing equipments.

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CRTEn (<http://www.crtten.mrt.tn>) is a public research establishment with financial autonomy. It represents the energy research component in Borj-Cédria Technopole. The centre has a human resource of about hundred researchers, engineers and technicians, and is organised in laboratories. Its mission is to undertake research and innovation activities on energy technologies, with special care to research in the field of renewable energy:

- Photovoltaic;
- Solar heating, solar cold;
- Wind energy;
- Modelling, controls and energy management.

In 2008-09 CRTEn started some basic research on hydrogen and fuel cells, and their integration with renewable energy sources. It has searched for collaboration with foreign institutions having experience in the field to boost the emergence of this research activity. Actually, in spite of the uncertainty on the role of hydrogen in the future world energy scenario [5-7], research on fuel cells and hydrogen from renewable energy is a strategic global issue inserted in the research programs all over the world and especially in the research programs of the EU [8-9].

As result of the CRTEn SWOT analysis the project was addressed to:

- enhance its expertise and know-how on fuel cell and hydrogen technologies and applications, due to the recently start up of this research branch;
- improve knowledge of young human resources in selected fields;
- acquire new technological equipments related to fuel cell and hydrogen;
- boost the access into the international scientific communities, networks and platforms on fuel cell and hydrogen technologies;
- increase CRTEn partnerships with research centres and industrial enterprises by improving its visibility at international level.

Then ETRERA project was finalised at the creation of a research network on renewable energies, with special care to hydrogen and fuel cells applications, by involving European research centres having experience in research and know how transfer. The project partners have been involved in coordinated activities to reinforce the research structure of CRTEn, through support in the construction of a new lab on polymer electrolyte fuel cells (PEFCs) and by transferring know how on hydrogen and fuel cells. Moreover, recruitment of young researchers having abroad working or studying experience has been planned to increase research capacities and the human potential. Finally the link of the project to other Euro-Tunisian initiatives and the involvement of political authorities have been foreseen for project sustainability.

2.1 Project partners

Looking at the SWOT analysis of CRTEn and in order to achieve the project scope, European entities with strong experience in hydrogen and fuel cells technologies and/or in technology and knowhow transfer was asked to participate as project partners.

1) The Institute for Advanced Energy Technologies "Nicola Giordano" (CNR-ITAE) (<http://www.itae.cnr.it>) has been chosen as project coordinator. It is an Italian research centre founded in 1980 and belonging to the National Research Council of Italy. It is one of European leading research centre in the fuel cells and renewable energy fields and a full member of the Fuel Cells and Hydrogen Joint Technology Initiative of the European Community taking part in several international research projects. CNR-ITAE research activity is based on a multidisciplinary knowledge and is aimed to the study of materials and components preparation and characterisation, as well as the realization of system prototypes and their application, including modelling and normative development. The staff is formed by about 70 persons. The research activity is organized in 4 sectors:

- Direct production of electric energy technologies.
- Hydrogen and clean fuels production.
- Energy transformation and storage technologies.
- Integration of new energy technologies and renewable.

2) Polytech Nantes (<http://www.polytech-nantes.fr>) is the Graduate School of Engineering of the University of Nantes. The University of Nantes is the largest University and second most important centre for research in the West of France. Polytech Nantes is a member of the Polytech Group, the first group of engineering schools in France. It has approximately 1.000 engineering students and more than 250 students preparing their pre-doctoral and doctoral thesis.

Three of its research laboratories have expertise in the energy field: Materials Sciences and Engineering Laboratory (LGMPA), Nantes Atlantique Electrical Engineering and Electronics Research Institute (IREENA) and Nantes Thermokinetics Laboratory (LTN). A group of researchers from these three labs have put their competences in common to design, build and optimize a fuel cell powertrain that equip a prototype car named Polyjoule that runs energetic race. With this car, in 2007 and 2010, Polytech Nantes has been the winner in the fuel cell category of the prestigious competition "Shell Eco Marathon - Europe" [10] from 2010 to 2012. In 2010. These three research laboratories of Polytech Nantes participate to the present project:

3) Innova BIC s.r.l (www.innovabic.it) was founded in December 1994 on the initiative of DGXVI in the sphere of a Community programme actuated by European Centres of enterprise and innovation (CEII or Business Innovation Centre). Its shareholders are, the Messina Municipality, the University of Messina and the Provincial administration of Messina. Innova BIC is an agent for local development to promote economic growth and employment in under-developed regions. Innova BIC is a full member of E.B.N. (European Business Innovation Centre Network). In 1997 it was recognised by the Ministry of Labour and Social Security as an "Agency for the promotion of Work and Enterprise". This Ministerial recognition meant the Company could certify the technical validity of projects for public utility works. In 2002 Innova BIC was certified ISO 9001 and in 2008 It was certified ISO 14001. Innova BIC acts as technology transfer agency for the development of the territory through training, project management, strategic consultancy, etc

2.2 Project action plan and objectives

The structure of the project action plan was defined according to the SWOT analysis and considering the partners' expertises.

CNR-ITAE and Polytech Nantes, with which there was a partnership background [11], supplied their expertise on fuel cell and hydrogen technologies development towards CRTEn. The knowledge transfer was focused on PEFC, more than on hydrogen technologies. The selection of PEFC among a wide range of existing fuel cells was based on the following considerations:

1. PEFC are candidates to supply energy both in residential, portable and transportation application;
2. PEFC can be used with different fuels (hydrogen, methanol, reformat gas);
3. CNR-ITAE has the knowhow for the design and testing of PEFC componets and systems [12-15];
4. Polytech Nantes has experience on PEFC stack integration in power trains [16-17].

The action plan was targeted to meet CRTEn's emerging needs, and it encompassed the following activities:

1. Exchange of know-how. – Two-way secondments of each research centre' staff was planned in order to boost two-way know-how exchange. Four seminars have been organized in order to train young researchers, Ph.D. students and post-doctoral researchers belonging to CRTEn. Seminars were staged by CNR-ITAE and Polytech Nantes, and opened also to European students and internal personnel. Fuel cell and hydrogen technologies have been considered: from the materials synthesis and characterisation, through components preparation and stack design, to fuel cell and FC systems testing and diagnostics, and hydrogen production and storage.
2. Recruitment – aimed at increasing research capacities and human potential of CRTEn by hiring into the present research staff young researchers with abroad working or studying experience.
3. Improvement of S&T research equipments – by the realisation of a new CRTEn laboratory dedicated to fuel cells. Through a learning-by-doing process, CNR-ITAE and Polytech Nantes assisted the CRTEn group in the design and realization of a 0-500W home-made fuel cell test station for PEFC, compliant with international standards.
4. Web Knowledge Platform – The consortium provided a Web based Platform to underpin all the project activities foreseen in the action plan. This platform supplied a virtual and sharing space, in order to strengthen a closer interaction between the project partners and project stakeholders. It comprises information facilities, a web site, and an expertises database concerning the three target research centres and open to scientific community.
5. Events – The Consortium organised events in order to enhance knowledge transfer from the three research centres towards international fuel cell and hydrogen community of researchers and industrial enterprises, above all belonging to MPC and European countries. The organisation of one international scientific conference and the participation to several international conferences was planned.

6. Dissemination – A set of actions aiming at increasing the visibility of the three entities and related research activities was considered. These actions provided information on relevant project activities and results. Communication was oriented to the main stakeholders among researchers, industrial entrepreneurs and policy makers regarding energy and innovation.

The project was organised into seven work packages (WP) with activities strongly related between each others. Work package leaders were defined looking at the specific experience, the work package goals and related activity. The results was a matrix structure where each action leader was claimed to manage not only personnel of his own centre but also people of partner entities. A structure not simple to be managed but really effective in addressing to a collaboration based on strong interactions between the partners all over the project duration. In Figure 1 a sketch of the project structure is reported.

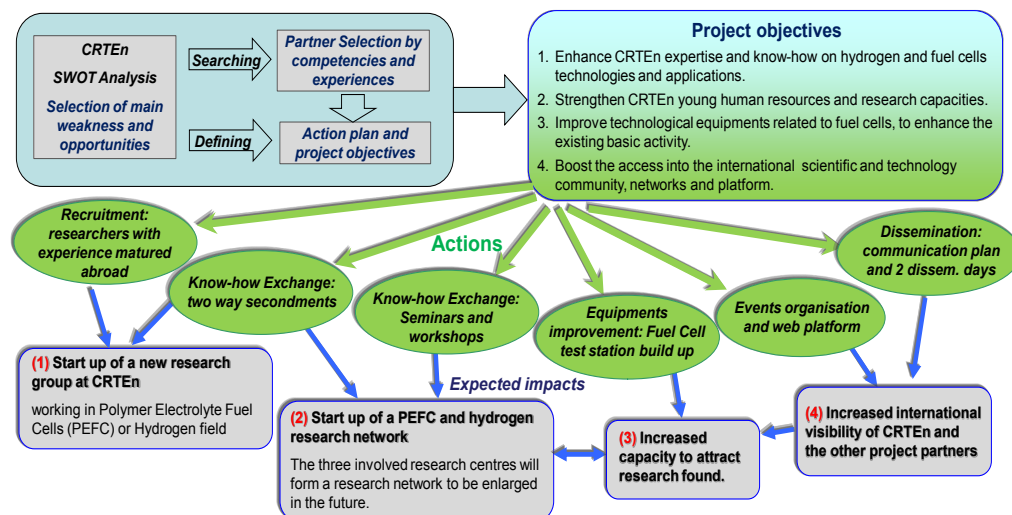


Figure 1: Sketch of the project design and planning process from SWOT analysis to expected impacts.

For each expected results a quantifier and target levels were defined:

1. Enhance CRTEn's expertise and knowhow, quantified by the official start up of a new research activity on fuel cell or Hydrogen technology.
2. Strengthen CRTEn young human resources, quantified by the formation of a research group composed by 3 or more persons.
3. Improve the CRTEn's equipments, quantified by the realisation of the test station and other instrumentation.
4. International visibility, quantified by the hits on the web site, number of registered user, number attendance to the international conference, number of

presentations in international conferences and number of publication in peer review journals.

2.3 Project time table and management

The preliminary project time table, defined at the proposal submission, was reorganised during the project kick off meeting and periodically revised along the project to face front the contingency.

In preliminary planning we considered, as reference for timing, the experience carried out in European research centres. Then, in agreement with the Tunisian partners the calculated reference time was adapted to account for differences in bureaucratic rules and research organisation between Europe and Tunisia. The result was a realistic executive program that allowed us to face front all the unexpected obstacles. Only for the “Arab spring” we was not able to reduce the impact to zero.

Moreover, the project steering committee was divided in 2 boards, one scientific and one “political”. The scientific board was in charge for the project execution and real time management, while the political board was in charge for assuring the connection with the policy makers and the local stakeholders (researcher, university, industry).

3. Results and discussion

Looking at the target quantification considered in the project, all the results have been reached, and in some case results exceeded the expectations.

Today, at CRTEn there is a research group working on PEFC’s materials and testing. The research leader, Z. Ahamed is associated professor in Sousse University and develop his research at CRTEn. He is supported by a team of about 12 people between researchers, engineers and PhD students.

We started by selecting new Tunisian researchers, with special regards to people having study or work experience abroad: one main investigator, having 4 years of experience on fuel cells matured out of Tunisia, 4 young researchers with study experience in Europe, and one engineer from Tunis engineering School. It is to be noted that some of the persons trained by the project have been recruited by Universities and Industries before the end of the project.

The CRTEn fuel cell laboratory is formed by two rooms dedicated to research, one for material preparation and one for testing, and three study rooms for researchers.

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Figure 2: PEFC test station built at CRTEn.

A fuel cell test station able to test PEFC single cells and stacks up to 500W, figure 2, the main tool of this laboratory, has been designed and built in strict collaboration between European and Tunisian researchers. The design was prepared according to international standards [18-20], allowing the start up of collaboration and the know how transfer about the problematic related to the realisation of a new experimental device. We used many components locally available for reducing construction and maintenance costs. Moreover there is the possibility for the local technicians to have a complete control of the test station maintenance, without the necessity of external specialised personnel for maintenance. These last two aspects will reduce maintenance needs incrementing project sustainability. Finally the complete knowledge of the structure will allow future flexibility, because Tunisian researchers will be able to modify the test station according to their necessities. So that the test station construction and utilisation have been the reference points for all the project activities.

In addition, an activity for membrane (one of PEFC components) development was started at CRTEn under the guide of Z. Ahamed. These studies have been addressed to material for direct methanol fuelled PEFC and conducted to the a publication on peer review journal [21] and two congress communications. This laboratory has become a point of reference for Tunisian universities, research centres and industries for testing components and materials for fuel cells.

About the international visibility, the number of expected hits on web site and the number of registered participant to the international conference was doubled and more. Two papers [21-22], related to the project activities, have been published. Both having as co-authors the Tunisian researchers who have been trained during the project. Others works, dedicated to project, have been published on newspapers and magazines. These results were obtained thanks to the project structure, to the flexibility proved by all partners and the pragmatic approach to each obstacle.

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About the project structure, as introduced before, the project activities have been organised with a matrix structure. Each work package leader, and task leader, managed not only activities realised in its own centre or regarding colleagues of his research group, but also activities realised in other structures and carried out by colleague afferent to other partners. For example, the seminars were managed by Polytech Nantes, but 2 of these were realised in Italy, and the large part of the attendants have been Tunisian researchers. This obliged the researchers participating to the project to be constantly in contact and created opportunities for the exchange of experiences. This interdependency was strongly used in dissemination activities for which all partners were involved.

The partnership considered dissemination activities and political support of fundamental importance for the project success and sustainability. For this reason since the kick off meeting we dedicated attention to these aspects. The first presentation of the project to large public was done just during the kick off meeting in February 2010. It was organised at the Italian culture Centre in Tunis with the support of Italian Embassy. The project was presented to Tunisian authorities, researchers and industries. Among the auditors there was also the presence of some representative of international diplomacy. Moreover the project was immediately linked to "European Tunisian Project (ETC)", a project aimed at the connection between the EU-TN collaborative project, by inviting its coordinator as component of the steering committee. Moreover the Europe, Italy and France Embassies in Tunis, and the Minister for high education and Research of Tunisia, has been invited to participate at the steering committee political board. This action granted a support when bureaucratic problems have been encountered. In particular we were able to organise a steering committee meeting in Tunis in February 2011, few time after the social disorders related to the Arab Spring, giving a clear demonstration of will to carry ahead the project. This was really important especially for the recruited young researchers.

Along the project, dissemination was operated by using all the possible channels. In addition to the WEB site [www.etrera.eu] and to a number of pages hosted by other web sites. Two info days on the project have been organised in Italy and in Tunisia. The project and its advancements have been presented, by oral or posters, in 7 international congress (including Hypothesis X), 1 international workshop and some national congress. Finally an international conference, EmHyTeC 2012, was organised in Tunisia with the aims of starting a conference series moving all around the Mediterranean sea. The conference hosted 121 participants of 20 countries from 4 continents, well over any expectation.

These actions allowed to reach a large public, especially in Tunisia, where the project became a reference best practice.

4. Conclusions

ETRERA was a project that has created a network that facilitates the transfer of knowledge and skills between the two sides of the Mediterranean sea.

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The particular structure of the project and realization of test station have proved effective in knowledge transfer. In fact, the staff of the various research centres had to constantly work side by side and then discuss and exchange information and data.

The results were:

1. Increase of Tunisian CRTEn research potentialities, by know how transfer and the start up of a new research group;
2. Start up of an hydrogen and fuel cells research network between the three research centres involved in the project;
3. An increased capacity of the partners in technology transfer and in research funds attraction.

In addition to the expected results, the project contributed to the hydrogen and fuel cell technologies diffusion and applications. For the future we would like to enlarge the number of collaborations up to the coverage off all Mediterranean countries, with the aims of support scientific and social growth in this area. ETRERA was the first step in this direction. Starting from this experience, a new and enlarged network has been creating in the framework Empowering Trans-Mediterranean Renewable Energy Research Alliance for Europe 2020 challenges [www.etrera2020.eu] This last project involve twelve partners from nine countries, and is aimed at the technology transfer from research to industry.

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