

<b>INNOSTORAGE</b> IRSES-610692		Deliverable number:	D7.2
		Title:	Report on Staff Exchange

**INNOSTORAGE – USE OF INNOVATIVE THERMAL ENERGY STORAGE FOR MARKED ENERGY SAVINGS AND SIGNIFICANT LOWERING CO<sub>2</sub> EMISSIONS**

Beneficiaries:



Partners:



**D7.2 - Report on Staff Exchanges**

	Name and Institution	Date
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## 1 Objectives

The objectives of the exchange have been:

- Use of TES for refrigeration applications
- Use of TES for solar cooling, CSP and other high temperature applications
- Waste heat recovery and reuse through TES

## 2 Introduction

Within the Work Package “Industrial Applications” of the Innostorage European Project I have been working in Analysis of new TES systems for building and industrial applications.

## 3 Description of work

While I was visiting University of Lleida and University of Barcelona in Spain during the period from 6/10/2014 to 11/12/2014, I have established a comprehensive research working programme with Prof. Luisa F. Cabeza and her team on the following areas:

### 3.1 Modelling of laptop cooler

Work Package: 3 (3.1)

Leading author: Dr. Albert Castell/ Dr. Alvaro de Gracia

Supervised by Prof. Mohammed Farid

The modelling work, which has not been done elsewhere, was conducted during my visit and we are in the process of finalising it for publication in the near future. This laptop cooler, which we have developed, showed the ability to prevent the heat generated from the laptop from penetrating to the human body and also reduce the running periods of the air fan, usually used for cooling, and hence reduce noise. The developed simulation can be used in a number of other applications.

3.2 During the week I stayed in University of Barcelona I have worked with Dr. A. Ines Fernandez, Dr. Camila Barreneche and Annabel Palacios (undergraduate student). Following a visit of their fire testing facilities, we have agreed on the establishment of research programme on testing our microencapsulated products, produced at University of Auckland, including those produced through our patented process. These tests are essential for future commercialisation of our microencapsulated products.

3.3 Established a comprehensive plan for the research which will be conducted by Reza Barzin (PhD student at University of Auckland) at University of Lleida during the period of January and February, 2015. Details are given in 2 and in its report.

3.4 Discussed the possibility of applying for a joint application on “high temperature energy storage for solar air-conditioning” for future funding from Qatar Foundation.

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3.5 Being in charge of deliverable D3.1 “Industrial Application” I have checked and edited the report submitted by the team to Cristina Dominguez, University of Lleida, Spain.

Moreover, we are discussing the last two activities left in the project:

- INNOSTORAGE conference: it will take place in Beer-Sheba, Israel, in 16-18 February 2016. This will lie within my next visit in this programme so I will be involved in the organisation of the conference. We have already started planning for the conference with Prof. Gennady Ziskind, our partner of the project who is in charge of the conference. Third Training School: after the first two successful training schools, the final third one will be about “Thermal Energy Storage applications”.

## 4 Results

We have established an ongoing collaboration with both University of Lleida and University of Barcelona that has enabled joint publications and planning of the on-going research of the Programme. INNOSTORAGE allowed us to expand our research activities to a number of applications including the development of efficient On Farm milk cooling, which is going to be critical to New Zealand in the coming couple of years. We have also started work on compressed air/ PCM as a new industrial application.

This collaborative exchange has enabled:

- use of techniques, equipment or resources, unavailable in New Zealand
- adoption of new methods currently unavailable in New Zealand
- leveraging of overseas funding
- New Zealand expert advice to influence international institutions
- international recognition of New Zealand as a centre for innovation

We have utilised the excellent fire testing facilities at University of Barcelona to assess the fire resistance of all the PCM products and microcapsules we are manufacturing. We have provided access to our PCM microencapsulation equipment to those who have visited us through this programme. We have also made available the unique data we have generated during that last 6 years on the benefit of using PCM in buildings. Our PhD student, during his visit to University of Lleida, has introduced to them the technique, which we have developed for the first time, on using price-based control of heating and cooling of buildings incorporating PCM.

With regards to international recognition, recently we have been invited as a Guest editor for the journal Applied Sciences to edit a special issue on Phase Change Materials (PCM).

We have also extended our collaboration beyond our European partners to other places such as AllCell Technologies Lt in Chicago and the University of Antofagasta in Chile, where I have given a talk about our PCM activities.

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## 5 Outcomes or future work

Grant: (a) Will submit a joint proposal for funding to Qatar Foundation on the subject “energy storage with phase change for solar refrigeration” (b) we have recently received an MBIE grant on food which includes the development of low temperature PCM for On-Farm Milk Cooling, in collaboration with Massey University

Publications:

Published:

- A. Castell, M.M. Farid. Experimental validation of a methodology to assess PCM effectiveness in cooling building envelopes passively. *Energy and Buildings* 81 (2014) 59-71.
- S. Serrano, C. Barreneche, A.I. Fernández, M.M. Farid, L.F. Cabeza. Composite gypsum containing fatty-ester PCM to be used as constructive system: Thermophysical characterization of two shape-stabilized formulations. *Energy and Buildings* 86 (2015) 190-193.

Submitted:

- J. Giro-Paloma, R. Al-Shannaq, A.I. Fernandez, M.M. Farid. Preparation and characterization of microencapsulated phase change materials for use in building applications. Submitted to *Journal of Energy Storage*.
- S. Ushak, P. Marin, Y. Galazutdinova, L.F. Cabeza, M.M. Farid, M. Gràgeda. Corrosion study of hydrated salts with potential use as inorganic phase change materials. Submitted to *Applied Energy*.

Other

- M.M. Farid, Invited Speaker to “Seminar on Energy Storage” organised by Universidad de Antofagasta, Chile, 7-9 July 2014.
- M.M. Farid, Invited keynote, “Energy Storage between Industry and Domestic Applications”, Conference of Higher Studies in Chemical Engineering, University of Technology, Iraq, 18-19 May 2015.
- *Mohammed Farid\*, Reza Barzin, John Chen, Brent Young* “ Peak Load Shifting With Energy Storage and Price-Based Control System”. Proceedings of the 9th SDEWES Conference on Sustainable Development of Energy, Water and Environment Systems, 20. - 27. September 2014 in Venice/Istanbul

Regarding the Future Collaborations:

- Dr. Svetlana Ushak and Dr. Mario Gràgeda. University of Antofagasta, Antofagasta, Chile.

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The Department of Chemical and Materials Engineering at the University of Auckland has been working on energy storage with phase change materials for more than 15 years. Our research unlike many world institutions covers a wide range of activities including PCM synthesis, microencapsulation, and large number of applications ranging from building and cold stores to cooling of microelectronics. Our participation in this exchange programme with our European partners has given us the opportunity to undertake testing of our innovative PCM products and also expand to other application such as high temperature solar energy storage.