

## **Symposium on Material Development for Thermal Energy Storage - Phase Change Materials and Chemical Reactions**

### **Executive Summary**

June 4-6 2008  
Bad Tölz

The Implementing Agreement “Energy Conservation through Energy Storage”, ECES of the International Energy Agency, IEA, and The Bavarian Centre for Applied Energy Research, ZAE Bayern, organized a Symposium on material development for thermal energy storage.

### **Symposium Scope**

The goal of this Symposium was to define needs for research and to establish teams for further activities, which include material science and Thermal Energy Storage (TES) application expertise. Furthermore the scattered international activities in material research and development for thermal energy storage should become more structured and better coordinated.

There is a wide gap between basic research on materials like PCMs or novel adsorbents and the more applied R&D dealing with TES applications of these materials. The potential users of these technologies, e.g. equipment manufacturers, do not always realize the possibilities of innovative materials, while on the other hand there is often a lack of understanding for the real requirements for a material in its application. Therefore it is necessary to bring experts from both fields together and give them the opportunity to communicate.

To achieve this aim the format of the symposium did deviate from conventional scientific congresses that mainly present R&D results. The focus of the event was to encourage fruitful discussions hence all participating companies and institutes were introduced at the beginning of the symposium. All participants, their expertise and their special interests in the outcome of the event were presented briefly. Each session was opened by two invited presentations (only), one speaker representing the viewpoint of academic materials science, while for the second part of each session representatives from applied research were invited. After that an open and sometimes very lively discussion took place. At the final session a summary of all discussions was given.

The symposium was at the same time a starting event for a new initiative of two different Implementing Agreements within the International Energy Agency IEA: The ECES and the Implementing Agreement on Solar Heating and Cooling, SHC.

### **Participation**

About 80 participants from 11 countries attended the Symposium. This was quite a large number of specialists for such a narrow topic like “material development for thermal energy storage” focusing on latent and thermochemical TES only. Most of the participants attended the whole 3-days’ event. Most of the participants came from Germany, followed by Spain, France and The Netherlands.

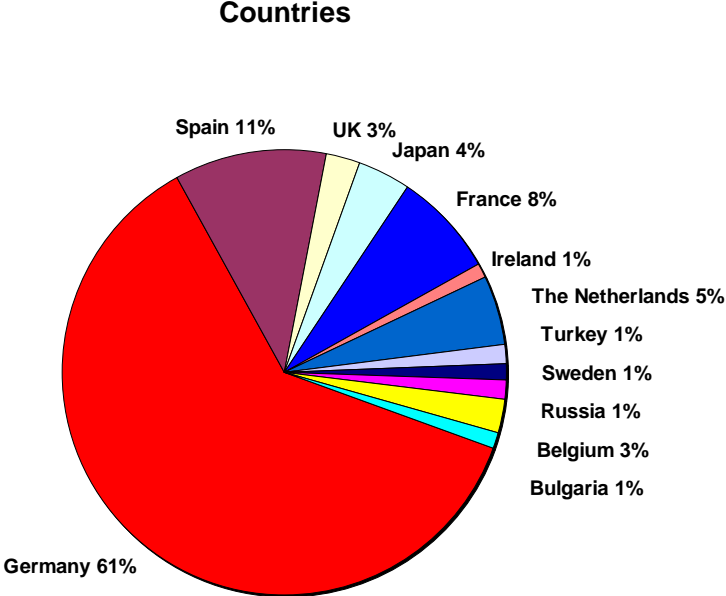


Figure 1: Participants in the Symposium (countries)

To match the goal of the symposium it was crucial to have all the parties present: Experts from basic material science, from applied science and from industry. Only with this mixture of expertise a joint approach towards a better coordinated R&D is possible. Figure 2 shows that almost an ideal distribution of that expertise was present at the meeting: One third of all participants came from each group. In Figure 2 the experts from industry were divided into “material” and “systems“ oriented. Both of them are needed for the development of a final product.

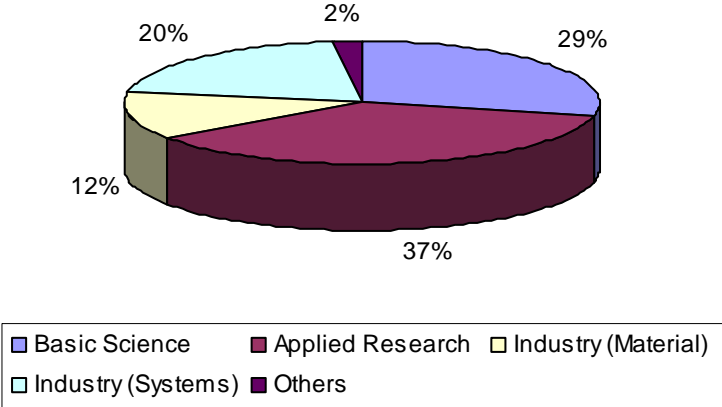
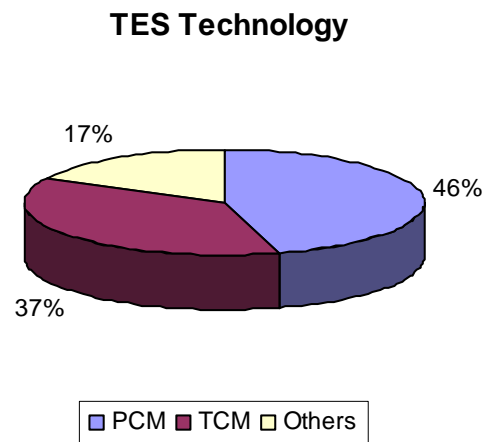


Figure 2: Participants in the Symposium (affiliation)

Concerning the technologies of thermal energy storage the participants are dealing with, the distribution is shown in figure 3. Most of the participants are active in PCM / latent heat storage, followed by experts on thermochemical TES. 17 % of the participants are dealing with heat pumps, energy concepts or sensible TES or are coming from funding institutions.



**Figure 3: Participants in the Symposium (TES technology)**

## **Program**

After an opening session, Georg Storch from the Bavarian Centre for Applied Energy Research, ZAE Bayern, gave an example of a thermochemical TES system integrated in an industrial product. This example clearly showed how the three communities - basic science, applied research and industry - have to collaborate throughout the entire development process. These “three languages” have to understand each other at all times. Even when a product enters the market material optimization by basic scientists remains important.

The introduction of all participants, their expertise and interest in the Symposium, was followed by the first session on the TES technologies – PCM and thermochemical processes.. Victoria Martin from KTH defined a list of requirements for PCM including safety, high thermal power, high energy density and low subcooling based on her experience in these applications. Xavier Py from the University of Perpignan talked about the possibilities in developing PCM and he brought up the expression of “dreams and nightmares” of this class of materials.

The second session on TES technologies dealt with thermochemical reactions. The focus of the session was on sorption storages. Peter Maier-Laxhuber presented a long list of developments of his company “ZeoTech”, which all were successes from the technological point of view, but most of them were failures in an economical sense. The presentation by Yuri Aristov from the Boreshkov Institute of Catalysis in Novosibirsk on the other hand offered many possibilities by the “nano-tailoring” of new adsorbent materials.

Franziska Scheffler from the ZAE Bayern went in the same direction by opening the first application session on “industrial applications”. She said, after defining the thermodynamical limits, the possibilities on the material side are still almost “infinite”. While Rainer Tamme from the German Space Agency (DLR) asked for new materials for high temperature applications at a reasonable price. He presented potentials for TES applications identifying industrial applications as by far the most important ones.

Hideto Hidaka from Mitsubishi Chemicals introduced a novel adsorbent material at the beginning of the session “other applications / from automotive to domestic appliances”. He also presented his vision of thermochemical TES in vehicles. Yukitaka Kato from the Tokyo Institute of Technology explained about the possible chemical reaction, which could be utilized while Eberhard Lävemann presented projects from the past where these systems were actually integrated in vehicles. This was happening almost exclusively in Truck, because the boundary conditions were in this application more favorable.

Both presenters in the “building”-session, Stefan Holst from Transsolar and Peter Schossig from the Fraunhofer Institut on Solar Energy Systems agreed that the building field is very conservative and that an economical benefit of innovative TES solutions is very difficult to achieve. However, the potential of TES applications in this field is enormous. The increase of comfort by the integration of TES might be the best possibility for commercialisation.

The last technical session dealt with solar applications. Manfred Reuß from the ZAE Bayern reported on a number of installed systems, most of them Underground TES used in water as a sensible storage medium. His conclusion was that even these systems are struggling with their economical performance. His counter-part Wim van Helden from ECN expressed his hope for achieving “10 times the storage capacity of water by using chemical reactions” and by doing so reaching the goal of very compact TES systems for solar applications.

The symposium was closed by a summary of the discussions and an outlook on future activities by Andreas Hauer from the ZAE Bayern.

## **Summary of Discussions**

Since there was a lot of time for discussions the exchange of ideas and opinions amongst the participants was very fruitful. The discussions in the technical sessions after the presentations did highlight some main topics, which will be summarized in the following.

The main technologies, PCM and sorption, are obviously in different stages of their development. While there is a huge variety of different phase change materials, there is a strong wish to find “one” material serving all needs. In the sorption field it is the other way around: At the moment only a few materials (Silicagel and Zeolites) are considered, but many more are possible candidates for TES applications. The requirements for an ideal PCM are well defined, while the properties of the ideal adsorbent and how these properties are influencing the performance of the TES systems are not really clear.

During the whole symposium it became very obvious that the different communities are speaking different “languages”. For example the material experts are describing the storage capacity by “kJ/mol”, while the application experts are talking of “kWh/m<sup>3</sup>”. At the same time the way from optimizing a material to the optimization of a system concerning storage capacity, thermal power and – last but not least – its price, is a very long one.

Most of the participants agree that in the future the impact of material properties on the performance and finally on the economics has to be identified. At the same time the potential of applications for TES has to be evaluated. This should be provided by the ECES and will be discussed at the executive committee meetings. For promising application fields it should be investigated where the highest costs in the system are. This gives an idea what a new developed material might cost.

The major outcome of the symposium was that the participants saw the gap between fundamental material science, applied research and industrial interests and that the different parties talked to each other. By doing that, they started to learn each others “languages” and saw the problems and needs of the others. The event was an excellent start of a joint effort to develop high efficient thermal energy storage systems, which can rally contribute to a higher overall energy efficiency and a reduction of CO<sub>2</sub> emissions world wide.

Garching 18.7.2008

Andreas Hauer

Organizer of the Symposium