Austrian Masterplan Thermal Energy Storage

Bernhard Zettl[1*], Wim van Helden[2], Dagmar Jähnig[3], Andreas Heinz[4], Michael Monsberger[5], and Gerald Steinmaurer[1]

[1] ASIC Austria Solar Innovation Centre, Roseggerstraße 12, 4600 Wels, AUSTRIA

[2] RENEWABLE HEAT, Oosterstraat 15, 1741 GH Schagen, THE NEDERLANDS

[3] AEE Institut für Nachhaltige Technologien, Feldgasse 19, 8200 Gleisdorf, AUSTRIA

[4] IWT, Graz University of Technology, Inffeldgasse 25b, 8010 Graz, AUSTRIA

[5] AIT Austrian Institute of Technology, Giefinggasse 2, 1210 Wien, AUSTRIA

[*] Corresponding Author, zettl.bernhard@asic.at

Abstract

Novel, compact thermal energy storage technologies are of key importance to achieve the national long-term renewable energy targets. Only with a programmed approach for fundamental and applied R&D and industrial development, it is possible to get these technologies to the market. The project aim is to set up the Masterplan-TES-AT that describes the actions and measures needed to obtain the proper R,D&D infrastructure in Austria. The project is a cooperation of the following institutes: AEE Intec, AIT, ASIC and IWT.

1. Introduction

The storage of thermal energy is of key importance to arrive at a very high share of renewable heat in the Austrian energy consumption mix. Especially for solar thermal energy the fraction of renewable heat in households, utilities and industrial processes can only attain high values if existing thermal storage technologies are greatly improved and novel technologies are developed.

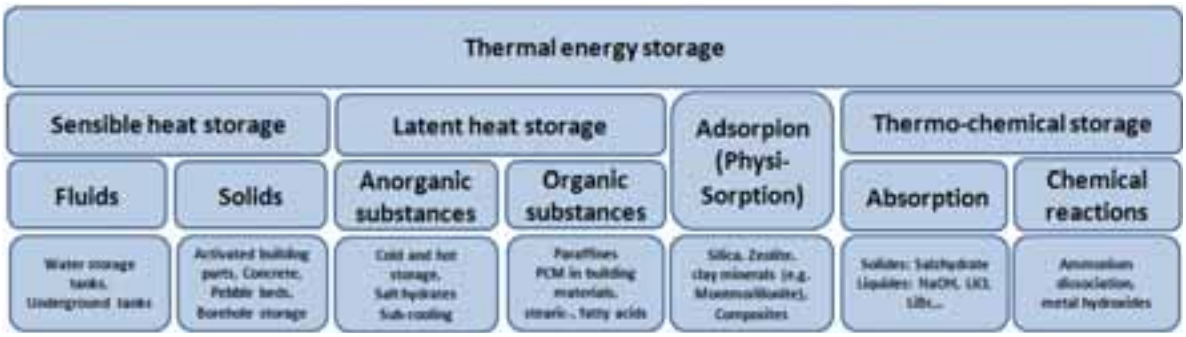

Fig. 1. Storage technologies

The technologies for storage of thermal energy can be divided into sensible heat storage, latent heat storage, sorption heat storage and thermochemical storage (Fig.1). In this sequence, the first technology has the broadest application and less potential for improvement, while the last has the

highest potential but is still in an early research stage. The broad range of technologies, materials and system applications involved implies that the further development can only be done by universities and institutes collaborating on a national and international scale.
The effective development of new and improved thermal storage technologies needs a well established R&D network, in which there is a programmed collaboration between industry, R&D institutes and universities.
At present, Austria has a strong solar thermal industry and a well established collaboration between industry, institutes and universities in the field of technological and industrial development. The fundamental and applied research in the field of materials and components for storage, however, are not yet on a proper level.

2. State of research and development

Austria

In Austria different institutions have been involved in research concerning thermal energy storage. A lot of work has been done in the field of **sensible heat storage**. Activities of research have been e.g. the optimisation of water storage systems that are typically used in solar thermal systems and the analysis of building integrated storage of thermal energy by e.g. thermal activation of buildings elements. Especially in the field of water storage tanks there have been investigations about the optimum position and geometries of in- and outlets, the enhancement of the thermal stratification in the tank etc. Research on thermal energy storage in water was done by all institutions that are involved in solar thermal applications research. These are: AEE Intec, IWT, AIT and ASIC.

IWT has been involved in several research activities in the field of thermal energy storage with **Phase Change Materials (PCM)** in the last years. IWT was participating in the European Project PAMELA "Phase Change Material Slurries and their Commercial Applications", in which the use of suspensions of microencapsulated paraffins as a heat storage- and transport fluid was studied. In IEA SHC Task 32 "Advanced storage concepts for low energy buildings" the integration of PCMs into the water storage of a solar combisystem was analysed by means of dynamic system simulations. All of these projects showed that the PCM materials, which are currently available, do not meet the needs of the proposed applications and that there is a need for research with a dedication to an improvement of materials.

AEE Intec has been working on a **Sorption Storage** System with the materials combination water/silicagel for several years, beginning with an EU project (HYDES). The result was a first generation laboratory system. In the follow up EU project (MODESTORE), a more compact prototype was developed. This prototype was then tested in a pilot plant installation in a third (Haus der Zukunft) project. The results showed that the system is principally working but that the solar fraction, which can be achieved with this type of system, is not higher than with a standard water storage of the same volume. The reason is again that the used materials have to be improved in order to be able to use the full storage density.

All institutions involved in this project proposal (AEE Intec, AIT, ASIC and IWT) are participating in the new IEA SHC Task42 / ECES Annex24 on “Compact thermal energy storage; material development for system integration”.

International

The research into phase change materials (PCM) in Europe has already a track record of more than 30 years. A range of materials was investigated, both organic and inorganic PCMs, and further developed into market-ready products. Presently the R&D activities for PCMs are in a number of fields. More fundamental R&D is aimed at finding new materials and production methods for micro encapsulation of PCM, at developing methods to prevent de-mixing and ageing of materials and methods to combine different kind of materials to get improved functionalities. Applied research is done into improved production methods, encapsulation methods and blending PCM with other materials, for instance building materials. On system level, new storage and system configurations are being investigated. Especially for applications with a relatively high temperature difference the application of phase change materials is only competitive with water-based storage if new PCMs are developed with a higher storage density. Part of the recent R&D activities are aimed at this. Also, PCMs for higher temperature storage are being investigated since a few years now.

Research and development activities into sorption materials were originally aimed at finding suited sorption material for sorption cooling machines and at developing selective sorption materials, like zeolites, for separation purposes in chemical processes. Since more than 10 years now, research is being done into sorption materials for small and larger heat storages. Topics are methods to synthesize zeolites, to modify material properties, to develop new bonding methods between active material and carrier material and to lower the activation temperature of materials. On a system scale, research is being done into the optimal geometries of active material and the optimisation of mass and heat transfer processes to and from the active material. As for now, the material cost for synthetic zeolites is still relatively high. This could lead to a renewed attention for the application of natural zeolites, as these have lower prices.

The research into thermochemical storage materials (TCM) attained a new impulse a few years ago. There are more challenges in the application of these materials in heat storage devices, as the heat and mass transfer is more complicated and consequently the development includes chemical technology, necessary for reactor design. For low and medium temperatures the materials under investigation are salt hydrates or mixtures of hydrates with zeolites. The search here is for materials with optimal thermodynamic and structural properties. For higher temperatures, other materials like metal hydroxides are possibly suited. For the thermochemical materials, the research challenges are high and go into the basic principles. In fact, the research has just made a start.

A large part of the research institutes that work on PCM, sorption and thermochemical storage has joined the new IEA Task42/24 on “Compact Thermal Energy Storage: material development for

system integration". Presently, more than 41 organisations from 17 countries worldwide collaborate in this Task. The topic of compact thermal energy storage has won the interest of an increasing number of researchers, as can be seen from the growth in participants in this Task. On average, some 25% of the experts are material experts. The big material development challenges at hand require participation of more material experts. Actions on a national level, like the setting up of a Masterplan TES, will help to structure the field and to attract material experts from other fields.

3. Methods and Results

The goal of this project is to compose a Masterplan for Thermal Energy Storage research and development in Austria. In this Masterplan, the necessary and desired research and development activities are described in order to substantially increase the renewable share of heat in the future. The work will be done by the four Austrian institutes that have the best knowledge of thermal storage technologies. All stakeholders in Austria will be involved in the preparation process, through interviews and workshops. For each technology development a time line is described, stating the activities to be unfold on the level of fundamental, applied and industrial research. This leads to a description of the expertise needed and of the R&D infrastructure and estimated budget. The Plan is tuned to the international R&D plans and activities in order to maximise the effectiveness and to minimise the effort. With the plan, the position of Austria in the international R,D&D field on Thermal Energy Storage will be reenforced. The possibilities of realising a European institute for thermal storage research in Austria will be actively investigated.

The project goal is to produce the Austrian Masterplan for Thermal Energy Storage, with which the government can start an effective and targeted stimulation of R&D in the field of thermal energy storage. The actions laid down in the Masterplan will help to achieve the Austrian long-term renewable energy goals.

Experts and companies who undertake active research and development of innovative products are invited to take part of the workshops which will be held during autumn 2010 in Wels, AUSTRIA. Please contact the author for further information.

Acknowledgement

The Austrian Ministry BMFIT is gratefully acknowledged for funding the study.