ANNUAL REPORT

2012

International Energy Agency

Energy Conservation Through
Energy Storage Programme

ECES

Contents

Preface	I
Introduction	II
Chairman’s Report	IV
Ongoing Activities	VI
Further Activities	30
Executive Committee Members	33

Preface

ENERGY CONSERVATION THROUGH ENERGY STORAGE IMPLEMENTING AGREEMENT

The Implementing Agreement (IA) started in 1978. Its present term ends by the end of 2016. At present Contracting Parties from the following countries have signed the Implementing Agreement: Belgium, Canada, China, Denmark, Finland, France, Germany, Italy, Japan, Korea, Norway, Sweden, Turkey, USA and IF Technologies from The Netherlands, the Institute of Heat Engineering (ITC) of the University of Technology, Warsaw, Poland and University of Lleida from Spain as sponsors. The Executive Committee is working intensively to attract more countries to not only join the activities but also sign the Implementing Agreement. New Zealand, Slovenia, Australia, Brazil, Bulgaria, India, Israel, Malaysia, South Africa and Switzerland are interested. Experts from several countries do already participate in the Annex work as observers. According to the new Strategy Plan (2011 - 2015) approved in 2010 the strategic objectives for the IA remain as follows:

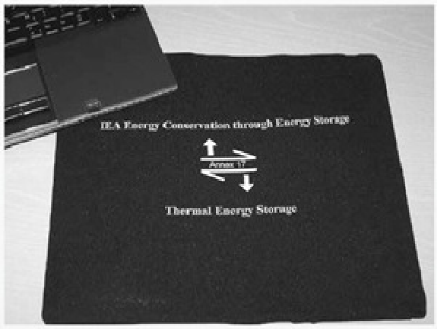
Technology: Maintain and develop international technical R&D collaborations that further the environmental and market objectives.
Environment: Quantify and publicise the environmental and energy efficiency benefits of integrated energy storage systems.
Market and Deployment: Develop and deliver information to support appropriate market deployment and provide effective collaboration and information to stakeholders.

The Executive Committee coordinates and leads the collaborative work in the Annexes and the Committee also takes an active part in various information activities such as workshops, seminars and conferences.

Introduction

We need energy - electrical or thermal - but in most cases not where or when it is available. Enjoying the sound of music while you are jogging, you can not stand beside the socket: electrical energy storages - batteries – make you mobile. The energy you need is stored for a short while and over the distance you like to run. Having a cold beer on a summers evening was possible even before cooling machines were invented. At that time people were cutting ice from the lakes in winter, transported the ice to the brewery and stored it in deep cellars. The cold was stored or the winter to the summer: An example for long term thermal energy storage and the utilization of renewable energies. In cold climates surplus solar heat from summer can be used in winter for heating of buildings by seasonal storage. Waste heat from industrial processes, steam from solar thermal power plants or electricity from photovoltaic panels are examples for energy sources, which can not be used more extensively without energy storages.

A huge potential of energy sources substituting fossil fuels can only be exploited by energy storage systems, utilizing renewables like solar thermal, PV and wind energy. Thermal and electrical energy storage systems enable greater and more efficient use of these fluctuating energy sources by matching the energy supply with the demand. This can finally lead to a substantial energy conservation and reduction of CO_2 emissions. The growing peak demand of today’s energy consumption, essentially caused by electrical air conditioning, leads more often to blackouts all over the world. Such a problem - the shifting of a peak demand for only a few hours or minutes - can be solved by cold storage technologies. In this context energy storages can be the best solution not only from the technical point of view, but also for economical reasons. The energy to be stored can be either electrical or thermal. Both energies require completely different storage technologies. However, in the actual application both technologies can meet: The peak demand of electricity for example is in most cases caused by air conditioning, which is a thermal task. The cooling demand can be covered by a cold store (ice or chilled water) which is charged at off-peak hours by electric chillers. Energy storages can be described by their storage capacity (stored energy per mass or volume), power (energy output per time), storage period (how long the energy should be stored) and size. All these parameters can vary over a huge scale: From latent heat storage to prevent laptops from getting too hot (stored energy in the range of a few Wh) to the heat and cold thermal underground storage system underneath the German Reichstag in Berlin (stored energy in the range of some 2 GWh).



Many governments have committed themselves to reduce CO_2 emissions into the atmosphere. They have decided to strengthen their national efforts and the international cooperation for research and development (R&D) in the International Energy Agency (IEA) and to increase the deployment of energy conservation technologies and utilization of renewable energy sources. So far in most industrialized countries, renewable energy sources contribute only marginally to satisfy energy demand. Energy storage technologies can help to solve problems caused by the intermittent energy supply of these sources. There is a huge potential for the application of energy storage systems. The fact that energy storage systems are not as widely used as they could is due to several reasons. In particular because most new storage systems are not yet economically competitive with fossil fuels and their long term reliability and performance is not yet proven. There are still some regulatory and market barriers which have to be overcome. Therefore further attempts are being made to resolve these issues. The IEA Implementing Agreement on Energy Conservation through Energy Storage provides the platform for international cooperation (www.iea.org) in R&D. After almost three decades of R&D the emphasis of the cooperative R&D efforts has shifted towards the implementation and optimal integration of new storage technologies for an efficient use of energy and renewable energy sources. In the future more application oriented topics like thermal energy storage for cooling and industrial processes or mobile thermal storage systems for the utilization of waste heat will be investigated. The issue of implementation and deployment of new energy storage technologies has become a higher priority as the R&D phase is concluding.

Chairman's Report

Recent climatic disasters have been trying to tell us that we have not done much in preparing for climate change. In an interview with Hard Talk of BBC television, IEA chief economist Dr.Fatih Birol warns us:

"We are currently in line with the 6-Degree scenario, which will be devastating for everybody – rich, poor, North, South, and everywhere. By 2017, we will see hotter days, more frequent climate disasters, even more rain…"

In just four years… How prepared are we? Super Storm Sandy caused havoc even around NYC in October 2012 . The US is becoming more energy-self-sufficient with its recent shale oil and gas explorations. Yet the country keeps releasing more and more CO_2.

Main technologies that will help us shift from the 6D Scenario to 2D scenario, are end use fuel and energy efficiency (42%) and renewables (21%) as given in IEA Energy Technology Perspectives 2012. Energy storage technologies are the central component of any system that can create the shift to 2D.

2012 has been yet another very active and productive year for ECES. Effective international collaboration has become more urgent than ever. Increasing the number of participant countries enhances ECES's strength and motivation. Denmark has reactivated their membership by assigning new delegates. Slovenia completed formal procedures and joined in 2012, the Netherlands started the process of signing our Implementing Agreement. We have new contacts in Australia as well as in New Zealand which are 2 potential new members.

From an IEA perspective, we started contributing to the preparation of an IEA Technology Roadmap on Energy Storage. Two representatives have been appointed from ECES at the Steering Committee of this roadmap. We are trying hard to accomplish that energy storage is represented with all its aspects and benefits in this roadmap.

We continue our co-operation with other IEA bodies. The EUWP chair, Mr. Carlos López participated in our XC73 and presented us the new EUWP strategy and procedures. I had the pleasure to present Energy Storage Technologies and ECES IA activities at the EUWP meeting in Paris, September 20-21, 2012. We are invited to present our ECES activities at the EUWP Workshop on Energy Efficiency in industry in 2013 and IEA ECBCS Future Buildings Forum. We are also taking part in Building Coordination Group (BCG).

Three annexes under development –which are expected to start in 2013 - include Annex 27 that aims to address quality assurance of borehole thermal energy storage systems. The second one being Annex 28: Integration of Renewable Energies by Distributed Energy Storage Systems. The third is Annex 29: Material Research & Development for Improved TES Systems. The scope definition workshop for Annex 28 has been organized in Paris on September 18-19, 2012 with 38 participants from 15 countries, including CERT Chair Peter Cunz, representatives from 7 Implementing Agreements and European Association for Storage of Energy - EASE. Each of these Annex topics has critical importance in increasing awareness, and in turn the success of energy storage projects.

One particular highlight of 2012 was our tri-annual international thermal energy storage conference that was held in Lleida, Spain during May 16-18, 2012. In Lleida's INNOSTOCK, a special session was held on IEA, with inputs from ECBCS and HPP IAs and EASE. A total of 239 papers included all energy storage topics: underground thermal energy storage, sensible, latent and thermochemical storage and electrical energy storage. The papers were presented by 36 countries during this conference. From among these papers, selected ones will be published in a special issue of the Applied Energy Journal. I must here congratulate Luisa Cabeza, the scientific chair and organization committee for making INNOSTOCK an astounding success.

The preparations for our next tri-annual conference have already started. The 13th International Conference on Energy Storage will be organized by China in Beijing.

I would like to thank our delegate Jorgen Sjodin from Sweden who will be leaving our group. I hereby give a very warm welcome to our new delegates who have joined us in 2012: Jens Windeleff, delegate and Per Alex Sorenson, alternate delegate from Denmark and Josefine Wejerstrand delegate from Sweden.

Last but not least, I wish to thank all the members of our Executive Committee, our Operating Agents, the experts of Annexes, our secretary Hunay Evliya, our webmanager Yeliz Konuklu, and the IEA desk officer John Dulac each, for their excellent contributions to the collaborative work and success of ECES.

Halime Paksoy, Chairman ECES

Ongoing Activities

In 2011 five Annexes were performed by the “Energy Conservation through Energy Storage” Implementing Agreement.

Annexes No	Title	Time Schedule	Operating Agent
21	Thermal Response Test	2007-2013	ZAE Bayern/Germany
22	Applying Energy Storage in Buildings of the Future	2009-2013	Concordia University/Canada
24	Compact Thermal Energy Storage: Material Development for System Integration	2009-2013	ZAE Bayern/Germany
25	Surplus Heat Management using Advanced Thermal Energy Storage Technology	2010-2013	University of Leida/Spain
26	Electric Energy Storage: Future Energy Storage Demand	2010-2013	Fraunhofer Umsicht /Germany

Annex 23 : Applying Energy Storage in buildings of the Future

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Duration of Annex:
The runtime of this Annex is from October 2009 until December 2013.

Overview of scope

Energy storage has often been applied in standard buildings that happened to be available. The objective was to demonstrate that the energy storage techniques could be successfully applied rather than to optimize the building performance. Indeed, the design of the building and the design of the energy storage were often not coordinated, and energy storage simply supplied the building demand whatever it might be.

Specific objectives of Annex 23 include:

- assess the potential of harnessing natural energy sources to supply building heating and cooling through energy storage;
- assess the use of energy storage to optimize the efficiency of distributed generation;
- develop and evaluate energy storage conceptual designs suitable for specific applications; and
- develop guidelines and procedures to estimate the environmental performance of energy storages when applied in ultra-low energy buildings and communities.

Countries participating and representing institutes:

Eleven countries are participating and contributing to this Annex.

Countries	Research Group
Canada	Concordia University Public Works Government Services Canada Laboratoire des Technologies de l'énergie d'Hydro-Québec
China	Tsinghua University
Denmark	Technical University of Denmark
France	CETHIL, INSA de LYON La Rochelle University École Nationale des Travaux Publics de l'État University of Savoie
India	Anna University (Observer)
Norway	Norwegian University of Science and Technology (NTNU)
New Zealand	University of Auckland (Observer)
Spain	University of Lleida University of Zaragoza
Sweden	Chalmers University of Technology Dalarna University
Turkey	Dokuz Eylül University
UK	University of Ulster

Activities / achievements:

A comprehensive review of energy storage use, the existing technologies, requirements, limitations, etc. was completed. The report consists of five chapters. The first chapter gives an overview of thermal properties of sensible and latent of building materials. The second chapter concerns passive thermal energy storage used for cooling and heating applications in buildings, while the chapter three describes active thermal storage at low and medium temperature including short-term storage (daily) and long-term storage (seasonal).

Chapter four focuses on the active storage systems at high temperature, and the methods used for high temperature storage namely sensible storage, latent storage and thermo-chemical storage. The last chapter concentrates on technologies used to store electrical energy.

The qualitative cross analysis between inventories of real applications (subtask A survey) and literature review (subtask B) indicated that the survey was comprehensive and almost included all the existing thermal storage except the snow stored in a shallow pond. In addition, none of buildings of the subtask A is equipped with thermo-chemical storage or electrical storage.

At the same time, extensive work has been performed on the modeling of new sustainable Thermal Energy Storage (TES) or improvement of promising existing systems that have potentials to be successfully integrated with a variety of ultra-low energy buildings. This active is performed by Task C. Several TES models have been developed/analyzed and the main results are:

1. Numerical benchmarking has been developed for the validation of numerical models dealing with solid-liquid phase change process. Two numerical benchmarking were developed and proposed to participants. The first one (Figure 1) represents the surface temperature evolution for a wall integrating a PCM whereas the second (Figure 2) deals with the temperature evolution inside a box. The figures show the comparison between experimental and numerical results obtained by different teams.

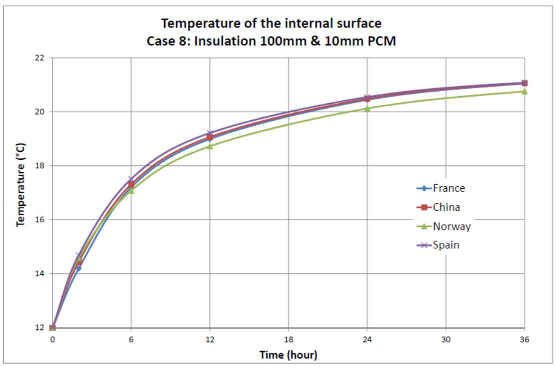

Figure 1: PCM integrated wall

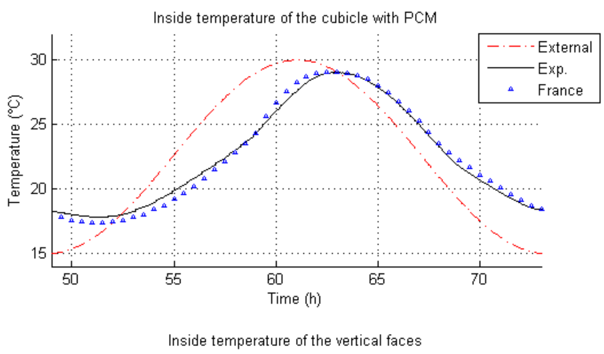

Figure 2: PCM integrated in a cubic box

2. Field measurements data from Task D were used to validate the developed models. There is a good agreement between the prediction made by the model and the experimental data, Figure 3.

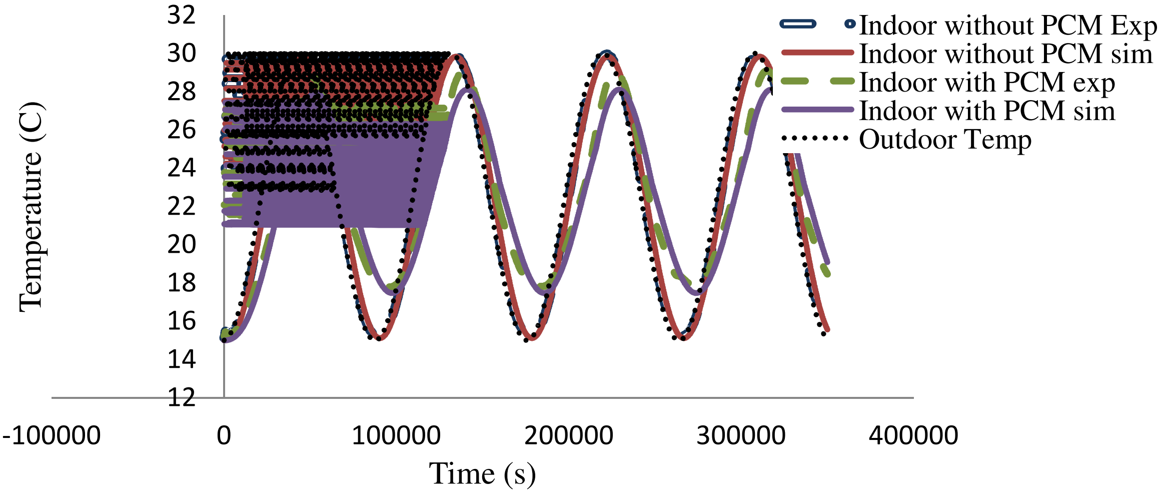

Figure 3 Indoor temperature profile of the benchmark cubicle with/out PCM (outdoor sinusoid change of temperature)

3. Further simulations have been performed to evaluate the performance of TES in low energy buildings. An example is given in figure 4. A passive standard single family house in a Nordic climate has been simulated where sensible or latent heat storage system has been evaluated. The results from this test case show that increased sensible thermal mass can reduce Space Heating (SH) demand and SH power, and further reduce excess temperatures. When using PCM, the phase change temperature is important : *i)* close to the heating set point gives largest reduction in SH demand, *ii)* close to the upper temperature limit results in largest reduction of excess temperatures.

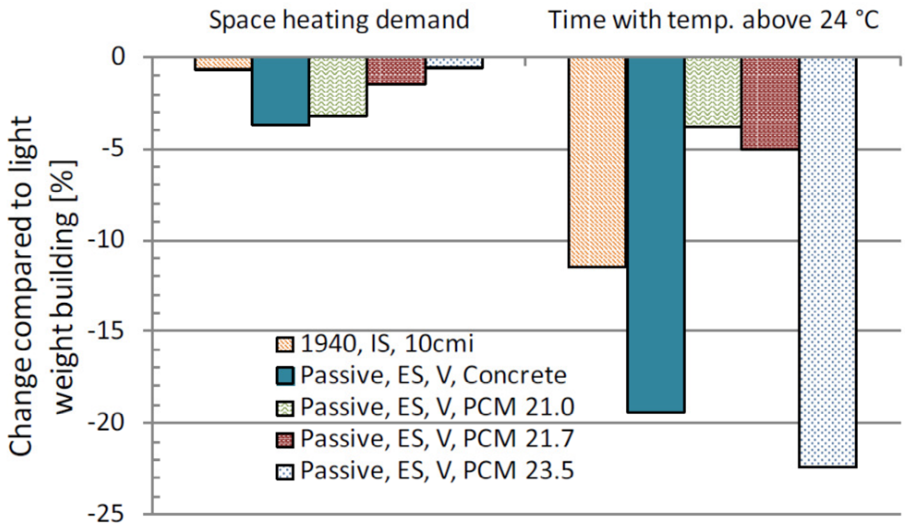

Figure 4: Gains obtained using TES in a light weight building

4. Further investigations are underway to study the performance of a Centralized Latent Heat Thermal Energy Storage System (LHTES) system. A three-dimensional heat transfer model of a LHTES system was developed to investigate the quasi-steady state and transient conjugate heat transfer problem of phase change materials (PCMs). The prediction of model was in good agreement with the available experimental data. The effect of convection heat transfer on the melting rate is assessed. A parametric study was carried out to study the effect of the PCM phase change temperature range, and the temperature difference of the incoming air and PCM melting temperature on thermal performance of PCM. The temperature difference between the air and the melting point has a significant effect on the performances of a centralized LHTES system. The highest simulated performance of a centralized LHTES system is observed when the temperature difference between the air and the PCM melting point is about 10K. Figures 4 and 5 show a typical evolution of PCM during charging and discharging. Figure 4 shows a typical evolution of solidification solid-liquid phase distribution as a function of time for vicinity of the fins. Solid layers start developing in parallel of the cooling walls at the top and bottom of the LHTES system. The solid interface shape is formed in a way resembling the lateral fin surface. The position of solid interface can be determined to identify the speed of solidification evolution.

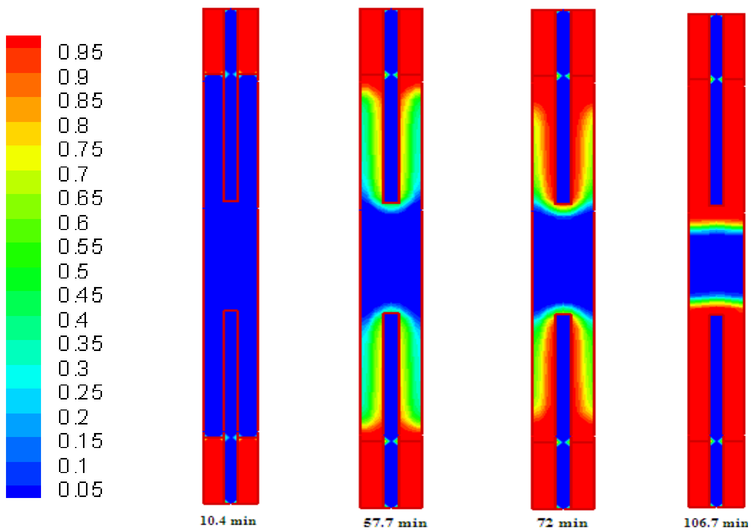

Figure 5: The liquid fraction and phase distribution of PCM as a function of time during melting process of energy release at the inlet air temperature of 36^{o}C and the velocity of 1.5m/s

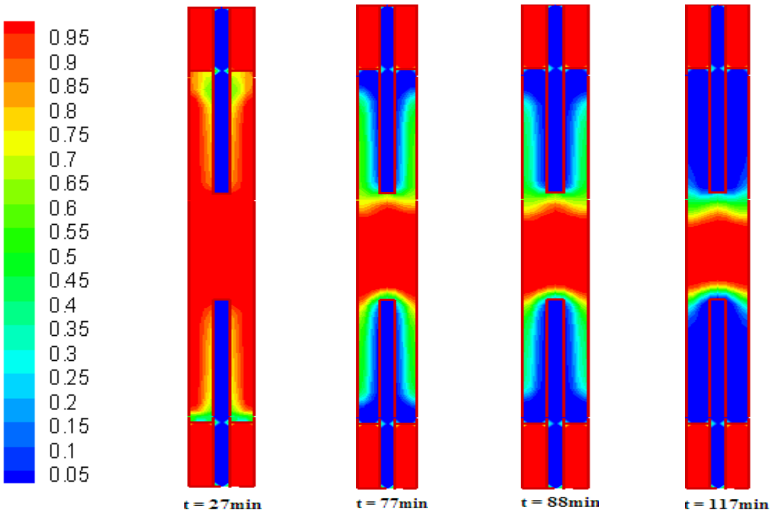

Figure 6. The liquid fraction and phase distribution of PCM as a function of time during solidification process of energy storage at the inlet air temperature of 36°C and the velocity of 1.5m/s

Free cooling is one of the novel methods of energy saving in building air conditioning systems. During daytime, the cool energy is retrieved from the storage device in order to cool the building using mechanical ventilation system. The modular heat exchanger developed in this work is a shell and tube type with phase change materials in the shell portion of the module and passage for the flow of air through the tubes. Transient and steady state CFD modeling is carried out for a single module and two air spacers, and the model prediction was validated with the experimental data. Figure 7 shows the variation of solidification time with velocity for various inlet fluid temperature, 7-a. for 293 K, 7-b. for 295 K. This work was carried out by Professor Velraj's group Of Anna University, India.

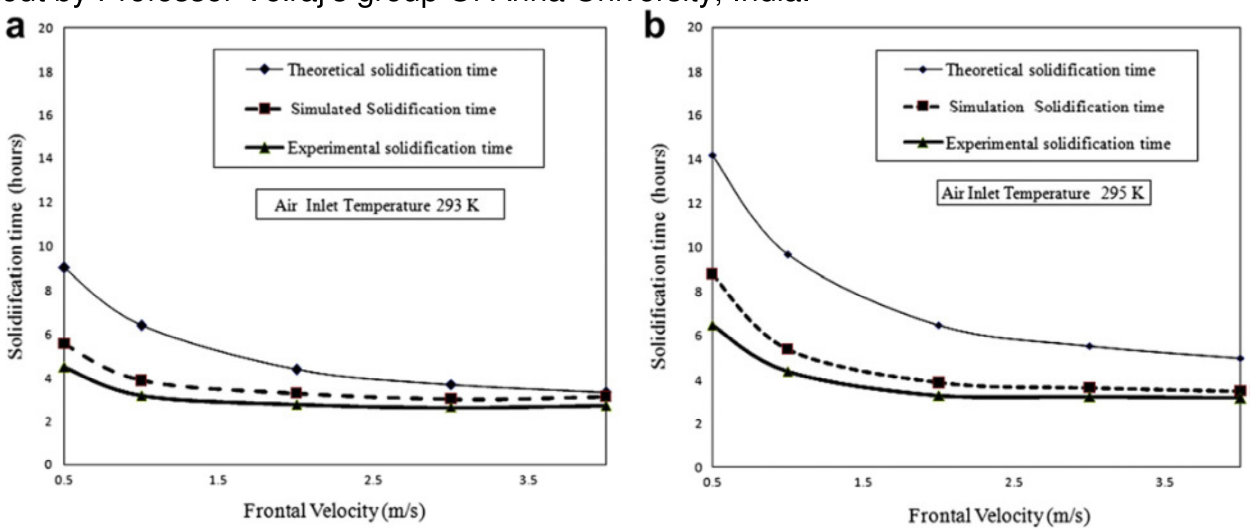

Figure 7: Variation of solidification time with velocity for various inlet fluid temperature, a. for 293 K, b. for 295 K.

In parallel extensive laboratory and field measurements have been carried out:

- Sensible passive systems

1. Sensible storage in real buildings (passive/active system?) – Chalmers University of Technology
2. Ventilated concrete wall (HVAC system) – University of Savoie
3. Vegetal facade (passive system) – University of Lleida
4. Vegetal roof (passive system) – University of Lleida
5. Water tank storage – Poitiers High school

- PCM passive systems

1. PCM in conventional brick facade (passive cooling) – University of Lleida
2. PCM in alveolar brick facade (passive cooling) – University of Lleida
3. PCM in concrete facade (passive cooling) – University of Lleida
4. PCM in wallboards (passive system) – INSA–Lyon
5. PCM in timber (passive system) – University of Auckland

- PCM active systems

1. PCM in ventilated facade (active HVAC) – University of Lleida
2. PCM in alveolar slab (active HVAC) – University of Lleida
3. Heat pump with PCM storage tank (active HVAC) – University of Lleida
4. Heat pump with PCM storage tank (active HVAC) – Buro Happold
5. PCM packed bed (cold storage) – University of Lleida
6. Water+PCM storage tank (Domestic Hot Water – DHW) – University of Auckland & University of Lleida
7. Heat exchanger – University of Auckland
8. Collector storage – University of Savoie
9. PCM in a radiant floor – University of Zaragoza
10. Ice storage – Anna University

The experimental data from some of these sites have been used by Task C for model verification.
This Annex is also trying to identify technologies and research program for supporting our future homes in the global era with new technologies, materials and spatial structures related to thermal storage in building elements that meet the needs and anticipated demands of the next generations while radically reducing resource and energy intensity.
There are a number of different solutions for storing heat in the building elements. However, there are still lack of product standard, testing standard and certification standards. The lack of standards makes it difficult for construction companies to choose these solutions.

Furthermore, detailed information are required about thermal behavior of these material/solutions, tools for assessment of economic, ecological benefits for decision makers,
LCA analysis, off-gassing, recycle-ability, fire behavior, and health issues.

Selected Publications:

1. Arce P, Castellón C, Castell A, Cabeza LF. (2012)Use of microencapsulated PCM in buildings and the effect of adding awnings. *Energy and Buildings* 44: 88-93.
2. Castell A, Menoufi K, de Gracia A, Rincón L, Boer D, Cabeza LF. (2012) Life Cycle Assessment of alveolar brick construction system incorporating phase change materials (PCMs). *Applied Energy* 101:600- 608.
1. Fuentes, J. M., Johannes, K., Kuznik, F., Cosnier, M., and Virgone, J. (2012) Melting with convection and radiation in a participating phase change material, *Applied Energy.*
2. Geetha, N.B.,and Velraj, R., (2013) Novel Concept of PCM Based Thermal Storage Integration in Active and Passive Cooling Systems for Energy Management in Buildings, *Energy Engineering*, 110: 41-66.
3. Geetha, N.B.,and Velraj, R., (2012) Passive cooling methods for energy efficient buildings with and without thermal energy storage – A review, Energy Education Science and Technology Part A: *Energy Science and Research*, 29: 913-946.
4. Goia F., Perino M, Haase M., (2012), A numerical model to evaluate the thermal behavior of PCM glazing system configurations. *Energy and Buildings*. 2012; 54:141-153.
5. Goia, F., Zinzi M., Carnielo E., Serra V. (2012) Characterization of the optical properties of a PCM glazing system. Energy Procedia, vol. 30, pp. 428-437
6. Goia, F. (2012) Thermo-physical behaviour and energy performance assessment of PCM glazing system configurations: A numerical analysis. Frontiers of Architectural Research, vol. 1, pp. 341-347
7. Goia, F., Boccaleri E, Perino M., (2012) Investigation of the thermal properties and heat-storage reliability of a paraffin wax for LHTES application under direct solar radiation.
12th International conference on Energy Storage, InnoStock 2012, Lleida, Spain.
8. Goia, F, Haase M, Perino M. (2012) A numerical model to evaluate the thermal behaviour of PCM glazing systems. *5th International Building Physics Conference (IBPC 2012)*, Kyoto, Japan
9. Heier, J. (2012), Thermal energy storage in Swedish single family houses - a case study, *12th International conference on Energy Storage, Innostock 2012*, Lleida, Spain.
10. Kumaresan, V., Velraj, R., Das, S.K., (2012) The effect of carbon nanotubes in enhancing the thermal transport properties of PCM during solidification, *Heat Mass Transfer*, 48: 1345-1355.
11. Karthikeyan, S., and Velraj, R., (2012). Numerical investigation of packed bed storage unit filled with PCM encapsulated spherical containers - A comparison between various mathematical models, *Thermal Sciences*, 60: 153 – 160.

12. Menoufi K, Castell A, Boer D, Perez G, Navarro L, Cabeza LF. (2012) Evaluation of the environmental impact of experimental cubicles using Life Cycle Assessment: A highlight on the manufacturing phase. *Applied Energy* 92: 534-544.
13. Mirzaie, P. and Haghighat, F. (2012) Modeling of phase change materials for applications in whole building simulation, *International Journal of Renewable & Sustainable Energy Reviews*", 16:5355-5362.
14. Nabavitabatabayi, M, Bastani, A., Haghighat, F. Kozinski, J., Dziedzic, M. (2012) A. Comparison of two numerical approaches of modeling phase change materials, *12th International conference on Energy Storage, Innostock 2012*, Lleida, Spain.
15. Pérez G, Vila A, Rincón L, Solé C, Cabeza LF. (2012) Use of rubber crumbs as drainage layer in green roofs as potential energy improvement material. Applied Energy 97: 347-354.
16. Rajagopal, M., Solomon, G.R., Jayasudha, C.K., Velraj, R., (2012) Free cooling potential and technology options for thermal energy management of a commercial building in Bangalore city, India, Accepted for publication in *Energy Engineering* (Taylor and Francis).
17. Safari, V., Barreneche, C., Castell, A., Bastani., A., Navarro, L., Cabeza, L. (2012) Volatile Organic Emission from PCM Building Materials, *12th International conference on Energy Storage, Innostock 2012*, Lleida, Spain.
18. Solomon, G.R., Karthikeyan, S., Velraj, R., (2012) Sub cooling of PCM due to various effects during solidification in a vertical concentric tube thermal storage unit, *Applied Thermal Engineering*, DOI: 10.1016/j.applthermaleng.2012.12.030.

Workshops/Special Sessions:

A number of special sessions and workshops were organized where the Annex members presented the outcomes of their work. The first was held in conjunction with the 12th International Conference on Energy Storage, INNOSTOCK 2012 which was held in Lleida, Spain. Also, a joint workshop of Annex 23 and 25 was held at the Fall Expert Meeting which was held in Auckland, New Zealand, where the Annexes participants presented their recent findings.

Annex 24: Compact Thermal Energy Storage: Material Development for System Integration

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Start: January 2009
End: December 2012

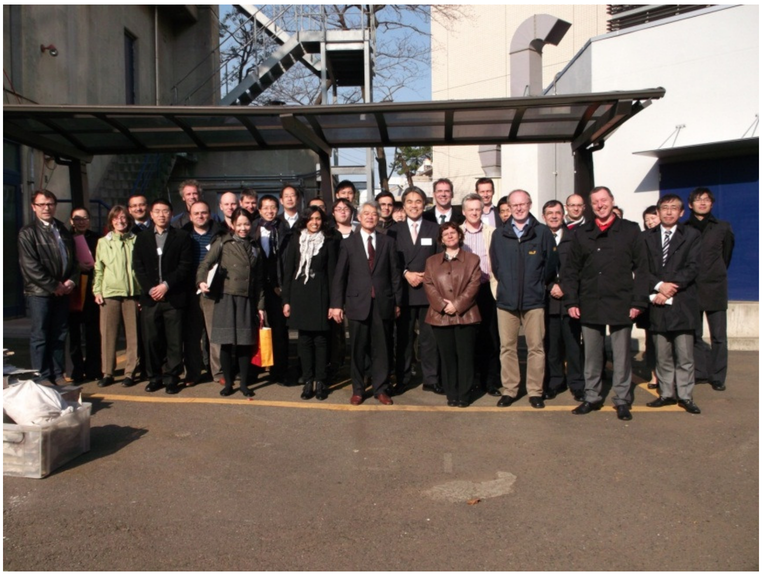
The objective of this joint Annex with the IEA Solar Heating and Cooling Implementing Agreement is to develop advanced materials for thermal energy storage systems, suitable not only for solar thermal systems, but also for other renewable heating and cooling applications such as solar cooling, micro-cogeneration, biomass, or heat pumps. The Task covers phase change materials (PCMs), thermochemical and sorption materials (TCMs), and composite materials and nanostructures. It includes activities on material development, analysis, and engineering, numerical modelling of materials and systems, development of storage components and systems, and development of standards and test methods.

The main added value of this Task is to combine the knowledge of experts from materials science with that of experts in solar/renewable heating and energy conservation.

Countries	Representing Institutes
Germany	ZAE Bayern
Germany	Fraunhofer ISE
France	University of Bordeaux
Japan	Chubu University
Spain	University of Lleida
Sweden	Royal Institute of Techonology
Turkey	Cukurova University

Activities / achievements

In 2012 two Experts Meeting and Workshops were organised. The 7th expert meeting was held in Tokyo, 27-29 March 2012, and was organised by the group of Prof. Kato at the Tokyo Institute of Technology. Apart from the hosting organisation, 21 experts attended the meeting. This made the group small enough to have all the discussions in one plenary meeting. Interesting presentations were given about the progress in the individual groups.

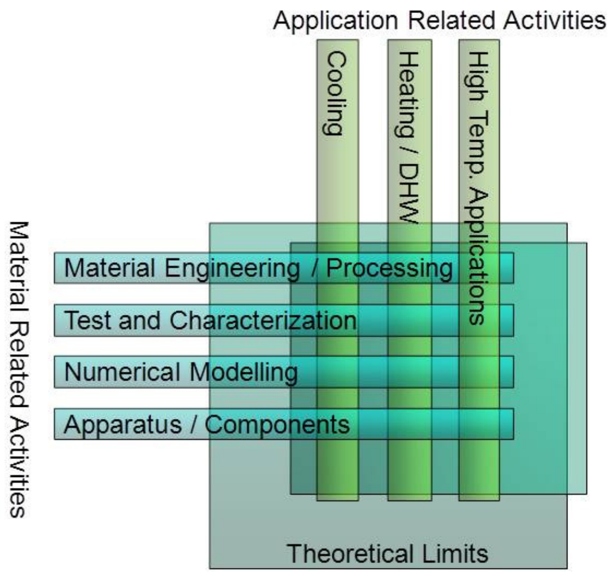


The final expert meeting was held in Petten, The Netherlands, 18-19 October 2012, and hosted by ECN, the Energy research Centre of the Netherlands. There was a large number of experts (54) participating in the meeting, as there were in the first four experts meetings of the Task. This is probably due to the fact that the meeting again was held in continental Europe and most of the groups active in compact thermal energy storage are from this region.

The work of this Annex is devided into 3 Subtasks:

- Material related activities
- Application related activities
- Theoretical Limits

Each of this Subtasks consist of different Working groups. Figure below shows the structure of the Annex.



In 2012 the work in each Working Group can be described as follows:

Materials engineering and processing: The activities in this Working Group focus on engineering new materials or composites, i.e. changing the properties of existing materials and developing new materials with better performance, lower cost, and improved stability. Eventually, this should lead to the ability to design new materials tailor-made to specification. The materials under consideration are those relevant to thermal energy storage using sensible mode, phase change, as well as chemical reactions and sorption technologies.

With respect to materials processing, the work focuses on the processing of raw materials that is required to make these materials function in a realistic environment. In nearly all cases, storage material cannot be used to store heat in its raw form, but needs to be processed into a slurry, encapsulated, or otherwise processed.

work was done on the overview of new or improved compact thermal energy storage materials. The information material will be put together in a main deliverable. In 9 chapters, the most important developments in materials for advanced thermal energy storages will be described. The chapters will cover sensible (high temperature) storage materials, phase change and thermochemical materials. The development work of several participating groups was published. Amongst others, it concerned the development of meso-porous silicates impregnated with a salt hydrate, solid-solid polymer phase change materials and novel metal organic framework materials.

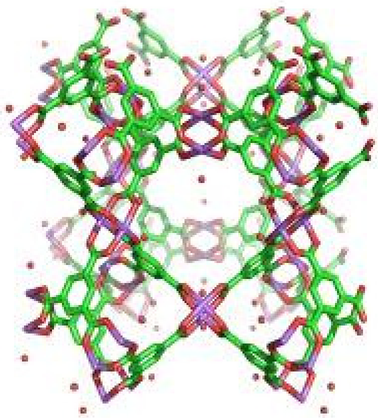


Figure 3: Molecular structure of Metal Organic Frameworks

The trial version of the materials database was tested and finalised and will be filled with material properties in the coming years with both phase change materials and thermochemical materials.

Materials testing and characterisation: The performance characteristics of novel thermal energy storage materials, like phase-change materials or thermochemical materials, often cannot be determined as straightforward as with sensible heat storage materials. In order to have proper comparison possibilities appropriate testing and characterisation procedures should be developed and assessed.

Reports were prepared on the definition of draft standards for performing Round Robin Tests with phase change materials and with thermochemical materials. These are the outcomes of the round robin test and the DSC measuring and characterisation workshop that were done in the Task. This work was also published.

Numerical modelling: The activities in this working group are aimed at developing and testing numerical models that help to understand and optimise the material behaviour and the dynamic behaviour of compact thermal energy storage systems and components. Ultimately, these numerical models could help to find ways to optimise the materials in combination with the system components. The activities in this working group help to lay the foundation for such models in the different scales from micro-scale modelling to thermo-mechanical modelling.

Experimental data sets were assembled that will be used as a reference base for the numerical tools that are developed by the different groups in the Task. Experimental data sets are available for 4 configurations with phase change materials and 5 with thermochemical materials. The sets are all described in a report, to be published in the spring of next year.

Apparatus and components: The storage apparatus is composed of the storage material and the equipment necessary to charge and discharge the storage material in a controlled and optimal way. This includes heat and mass transfer equipment like heat exchangers and pumps or fans and (chemical) reactors. Methods for the design and optimisation of components and apparatus should be developed, together with appropriate testing methods and procedures to assess the long-term behaviour of an apparatus. In 2012 there was very little progress in this working group. The finalisation of the work on design process descriptions and on the performance test protocol is to be done in the spring of next year.

Application working groups: There are several applications for compact thermal energy storage technologies, each with a different set of boundary conditions for the technology. The activities in these Working Groups serve the underlying guidance principle of the materials development within the limitations of the application. The materials development will be directed by the desired system performance. A constant assessment of performance criteria for a given application will be used to determine the chances for a given material/system combination. These criteria can come from economic, environmental, production technology or market considerations.
This subtask is subdivided in three Working Groups, each representing a particular application or group of similar applications:

- Working Group: Cooling
- Working Group: Heating / Domestic Hot Water
- Working Group: High Temperature Applications

The Cooling application working group drafted the final report. It describes two cooling applications as case studies for their boundary conditions for storage materials. A reporting template for description of cold storage applications was designed and will be used to gather information on a larger number of cold TES applications.
For the Heating and Hot Tap Water working group, a first draft of the final report was made, including the material for the three deliverables: Description of systems and materials, Laboratory prototype development and testing and simulated technical potential.

In the High temperatures application working group, the report for the State of the art overview was finalised.

Figure 4: High-temperature storage component, developed at the University of Lleida

Theoretical limits: The objective of this Working Group is to determine the theoretical limits of compact thermal storage materials and systems from a physical, technical and economical viewpoint. In short, this Working Group defines the maximum possible performance that can be expected from a thermal storage system in a given application. As such, it gives a reference point with which the performance of lab tests, field tests, and real-life systems can be compared. In a first step physical limits were determined, e.g. the energy stored per volume and per mass as a function of temperature, with respect to different mechanisms as sensible, latent, sorption or chemical storage. In a second step technical aspects were evaluated. In many cases the energy storage density and the efficiency of the system are deteriorated when a large specific thermal power must be drawn from the system. The study into the economical limits of thermal storage was drafted and discussed. The part on top-down economic approach is finalised and will be reported in the deliverable.

Other Achievements: During 2012, four large EU funded R&D projects were launched. Three are aimed at development of novel compact thermal energy storage systems and one on research into novel low to medium temperature phase change materials. These projects give the R&D into advanced TES a boost and will contribute to the activities in the follow-up of this Annex.

Continuation of the Work in a new Annex in 2013

2012 was the last year of Annex 24. Next year, a new Annex running for three years will start. Key activities for this continuation, planned for 2013 include:

- Gathering of experimental data for the materials data base
- Testing of the practical value of the experimental data for numerical tool validation
- Further discussion on replicable test methods for compact thermal storage materials
- Start with bottom-up economical approach for thermal energy storage systems

Selected Publications

- Iype, E., Gaastra - Nedea, S.V., Rindt, C.C.M., Steenhoven, A.A. van, Zondag, H.A. & Jansen, A.P.J. (2012). DFT study on characterization of hydrogen bonds in the hydrates of MgSO4. Journal of Physical Chemistry C, 116(35), 18584-18590.
- Jeremias, F., S. Henninger, et al. (2012). "High performance Metal-Organic-Framework Coatings obtained via Thermal Gradient Synthesis." Chemical Communications.
- Ristić, Alenka, Zabukovec Logar, Nataša, Henninger, Stefan K., Kaučič, Venčeslav. Small-pore microporous aluminophosphate for solar thermal energy storage. V: XXXV annual meeting of the British Zeolite Association, 15th - 19th July 2012, University of Chester, United Kingdom. Promoting the science of nanoporous materials. Chester, 2012

- Belusko M., Halawa E. & Bruno F., 2012 Characterising PCM thermal storage systems using the effectiveness-NTU approach, International Journal of Heat and Mass Transfer, Vol. 55, (13–14), 3359-3365.

- Cemil Alkan1,2,*, Eva Günther1, Stefan Hiebler1, Ömer Faruk Ensari2, Derya Kahraman2 Polyethylene glycol-sugar composites as shape stabilized phase change materials for thermal energy storage Polymer Composites Volume 33, Issue 10, pages 1728–1736, October 2012.

- M. Delgado, S. Gschwander, A. Lázaro, C. Peñalosa, B. Zalba, Determining the rheological behavior of octadecane as phase change material: First approach. Thermochimica Acta, 548-20, pp. 81-87. 2012

- Quinnell, J.A., and Davidson, J.H., "Distributed Solar Thermal: Innovations in Thermal Storage," in Advances in Heat Transfer Vol. 15, G. Chen, ed., Begell House Publishers, to appear, 2012.

Annex 25: Surplus Heat Management using Advanced TES for CO_2 Mitigation

Contact Information of Operating Agent

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University of Lleida

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www.annex25-eces.org

Duration of the Annex: 2010-2013

Overview of scope

The general objective of this Annex is to identify and demonstrate cost-effective strategies for waste heat management using advanced TES. New knowledge will be generated with regards to:

- The potential for advanced TES to minimize process waste heat through better process integration, enabling the use of waste heat for internal heating demands or cooling demands (via heat driven cooling).
- The potential for advanced TES to cost-effectively increase waste heat driven power generation in industrial applications.
- The potential for advanced TES to enable external use of heat from industrial-scale processes through effective thermal energy distribution.
- The potential for advanced TES to increase the utilization of waste heat in vehicles like on-board cooling and minimization of cold-start.
- The potential for advanced TES to increase the use of waste cooling (e.g., the large cooling potential associated with LNG regasification) and free cooling for comfort cooling applications.

Thus, a sub-goal of this proposed annex is to really dig into the waste heat utilization issue from a very broad perspective and show the great potential for using advanced TES towards reaching a resource efficient energy system where waste heat (and cold) is minimized. This has a good potential for attracting a large number of participants from a variety of disciplines and levels of R&D (basic research to commercial systems).

Participating countries

Country	Institution	Contact name	Contact e-mail
Contracting parties or sponsors			
China	Tongji University	Prof. Dong Zhang	zhangdng@tongji.edu.cn
France	PROMES UPVD	Prof. Dr. Xavier Py	py@univ-perp.fr
	EDF R&D	Dr. Ali Bourig	ali.bourig@edf.fr
Germany	ZAE Bayern	Christoph Rathgeber	rathgeber@muc.zae-bayern.de
	DLR	Dr. Doerte Laing	doerte.laing@dlr.de
		Dr. Thomas Bauer	thomas.bauer@dlr.de
Japan	Osaka University	Prof. Kazunobu Sagara	sagara@arch.eng.osaka-u.ac.jp
	Tokyo Institute of Technology	Dr. Yukitaka Kato	yukitaka@nr.titech.ac.jp
Spain	University of Lleida	Prof. Dr. Luisa F. Cabeza	lcabeza@diei.udl.cat
		Eduard Oró	eduoro@diei.udl.cat
		Antoni Gil	tgil@diei.udl.cat
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	University of Barcelona	Dr. A. Inés Fernández	ana_inesfernandez@ub.edu
		Dr. Mònica Martínez	monicamartinez@ub.edu
	University of Zaragoza	Dr. Pablo Dolado	dolado@unizar.es
Sweden	KTH	Dr. Viktoria Martin	viktoria.martin@energy.kth.se
Turkey	Çukurova University	Prof. Dr. Halime Paksoy	hopaksoy@cu.edu.tr
USA	Lehigh University	Prof. Dr. Sudhakar Neti	sneti@lehigh.edu
Observers			
New Zealand	The University of Auckland	Prof. Dr. Mohammed M. Farid	m.farid@auckland.ac.nz

Activities / achievements

Workshops:

4th Experts meeting and workshop

14 May 2012

Lleida, Spain

28 participants from 7 countries

In conjunction with Innostock 2012

5th Experts meeting and workshop

25-26 November 2012

Auckland, New Zealand

17 participants from 6 countries

Joint workshop with Annex 23

Findings:

The main findings this year have been the establishment of a methodology to account for the CO2 mitigation due to the implementation of TES in different applications and of a methodology to account the embedded energy in TES materials included in TES systems.

Selected publications in scientific journals:

- Oró, E., Miró, L., Farid, M.M., Cabeza, LF. “Thermal analysis of a low temperature storage unit using phase change materials without refrigeration system”. International Journal of Refrigeration 35 (2012) 1709-1714.
- Oró, E., de Gracia, A., Castell, A., Farid, M.M., Cabeza LF. “Review on phase change materials (PCM) for cold thermal energy storage applications”. Applied Energy 99 (2012) 513-533.
- Oró, E., Miró, L., Farid, M.M., Cabeza, LF. “Improving thermal performance of freezers using phase change materials”. International Journal of Refrigeration 35 (2012) 984-991.
- Oró, E., Gil, A., de Gracia, A., Boer, D., Cabeza, L.F. “Comparative life cycle assessment of thermal energy storage systems for solar power plants”. Renewable Energy 44 (2012), 166-173.
- Navarro, M.E., Martínez, M., Gil, A., Fernández, A.I., Cabeza, L.F., Olives, R., Py, X. “Selection and characterization of recycled materials for sensible thermal energy storage”. Solar Energy Materials and Solar Cells, 107 (2012), 131-135.

Selected contributions to conferences:

- Musale, S.S., Behzadi, S., Farid, M.M. “Extraction of Phase Change Materials (PCM) From Demolished Building Materials”. 23rd International Symposium on Transport (ISTP23) Phenomena Auckland, New Zealand 2012.
- Behzadi, S. Farid, M.M. ”Long term thermal stability of organic PCMs”. The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Leung, W.H., Behzadi, S., Chen, J.J.J., Farid, M.M., “Computer simulation of the application of phase change materials in domestic dwellings and harvesting of roof cavity heat energy”. The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Al-Hajri, N., Behzadi, S., Chen, J.J.J., Farid, M.M., “Theoretical Prediction of the Eutectic Point of Mixtures Including Phase Change Materials Using Physico-Chemical Laws”. The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Oró, E., Miró, L., Farid, M.M., Cabeza, L.F. “Thermal response of a low temperature storage unit following power failure”. Lleida (Spain). The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Oró, E., Miró, L., Barreneche, C., Martorell, I., Farid, M.M., Cabeza, L.F. “Corrosion of metal and polymer containers for use in PCM cold storage”. The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Oró, E., Castell, A., Chiu, J., Miró, L., Martin, V., Cabeza, L.F. “Enhancement of the stratification in packed bed thermal energy storage systems”. The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.

- Barreneche, C., Gil, A., Moreno, P., Solé, C., Cabeza, L.F. " Thermal behaviour of d-mannitol when used as PCM: comparison of results obtained by DSC and in a pilot plant storage tank".The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Gil, A., Olives, R., Cabeza, L.F., Py, X. "Theoretical method for the change on dimension of thermal energy storage systems". The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Tay, N.H.S., Bruno, F., Belusko, M., Castell, A., Cabeza, L.F. "Experimental validation of a CFD model on a vertical finned tube heat exchanger phase thermal energy storage system". The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Barreneche, C., Gil, A., Solé, C., Fernández, A.I., Cabeza, L.F. "Influence of polymorphism in the thermal energy storage capacity of d-mannitol".The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Ruiz-Pardo, A., Salmerón, J.M., Cerezuela-Parish, A., Gil, A., Alvárez, S., Cabeza, L.F. "Numerical simulation of a thermal energy storage system with PCM in a shell and tube tank". The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Gil, A., Oró, E., Salmerón, J.M., Cabeza, L.F., Alvárez, S. " Experimental analysis of the effective thermal conductivity enhancement of PCM using finned tubes in high temperature bulk tanks". The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Navarro, M.E., Martínez, M., Chimenos, J.M., Fernández, A.I., Cabeza, L.F. "Optimization of a by-product compound for high temperature STES through design of experiments". The 12th International Conference on Energy Storage Innostock 2012, Lleida, Spain.
- Miró, L., Suresh, P., Gil, A., Navarro, M.E., Fernández, A.I., Cabeza, L.F. "Experimental characterization of high temperature sensible thermal energy storage solid industry waste materials at pilot plant scale".
- Miró, L., Suresh, P., Gil, A., Navarro, M.E., Fernández, A.I., Cabeza, L.F. "Caracterización de subproductos sólidos industriales como materiales de almacenamiento térmico sensible". XV Congreso Ibérico y X Congreso Iberoamericano de Energía Solar - CIES 2012, Vigo, Spain.
- Barreneche, C., Gil, A., Solé, C., Marínez, M., Fernández, A.I., Cabeza, L.F. "Influencia del polimorfismo del d-manitol en su uso como material de cambio de fase (PCM)". XII Congreso Nacional de Materiales y XII Congreso Iberoamericano de Materiales, 2012, Alicante, Spain.
- Oró, E., Gil, A., Miró, L., Peiró, G., Álvarez, S., Cabeza, L.F. "Thermal energy storage implementation using phase change materials in solar cooling and refrigeration applications". SHC 2012 - International Conference on Solar Heating and Cooling for Buildings and Industry, 2012, San Francisco, USA.
- Gil, A., Oró, E., Miró, L., Peiró, G., Ruiz, A., Salmerón, J.M., Cabeza, L.F. "Experimental analysis of hydroquinone used as phase change material (PCM) to be applied in solar cooling refrigeration". Eurosun 2012, Rijeka, Croatia.

- Kucukaltun, E., Paksoy, H., Evliya, H., New binary mixtures as phase change materials for industrial process heat applications,The 12th International Conference on Energy Storage, INNOSTOCK 2012, Lleida, Spain.
- A. Krönauer, E. Lävemann, A. Hauer. Mobile Sorption Heat Storage in Industrial Waste Heat Recovery, The 12th International Conference on Energy Storage, INNOSTOCK 2012, Lleida, Spain.

Researchers exchange

Researcher	Origin institution	Host institution	Topic	Dates
Eduard Oró	University of Lleida, Spain	The University of Auckland, New Zealand	Use of PCM for cooling applications	Sept-Dec 2012
Takahiro Nomura	Hokkido University, Japan	University of Lleida, Spain	Simulation of PCM tanks for solar cooling TES	Sept-Nov 2012

Annex 26: Electric Energy Storage: Future Energy Storage Demand

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(Fraunhofer Institute UMSICHT)
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Germany christian.doetsch@umsicht.fraunhofer.de

Duration of Annex:

2010 until 2013

Overview of Scope

The future of electricity network involves a massive penetration of unpredictable renewable energies. For insuring network stability as well as for maximizing the energy efficiency of such networks, storage is a key issue. Up to now, the integration of renewable energies did not take into account the demand side and was performed in a “fit and forget” way. The optimum evolution in an economic perspective is in the future to have an integration that is respecting the needs. One solution – beneath demand side management and grid extension – is the use of energy storages. The main purpose of adding energy storage systems in the electricity grid is to collect and store overproduced, unused energy and be able to reuse it during times when it is actually needed. Essentially the system will balance the disparity between energy supply and energy demand. Worldwide between 2% and 7% of the installed power plants are backed up by energy storage systems (99% pumped hydro systems). The future demand of energy storage devices is actually unknown. Only the main influence factors on this demand are known.

The main objective of this task is to develop a method or approach to calculate the regional energy balancing demand and to derive regional storage demand rasterizing the area and taking into account that there are competitive technical solutions.

Current participants:

Country	Researcher	Companies
Germany	Fraunhofer (OA), DLR, European Academy FfE, RWTH	RWE, EON, Next Energy, Evonik
Belgium	VITO	
France	INES-CEA	
Finland	VTT	

Activities / achievements

Cooperations

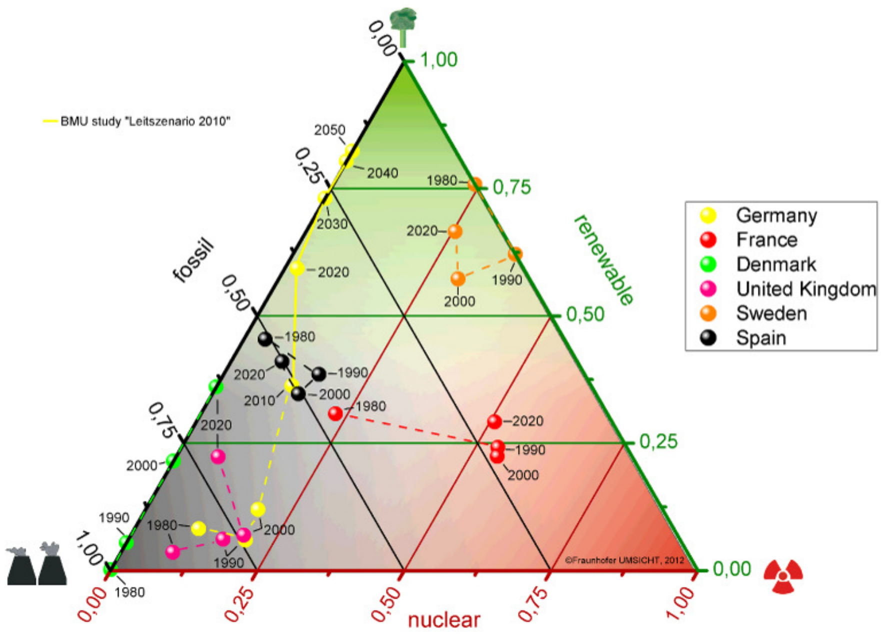
In 2013 a link to the new European Association for Storage of Energy (EASE) was established by membership of the operating agent in this association. Additionally a link to IEA HQ and their activities in modeling energy system and developing a roadmap for energy storages was initiated by the operating agent.

Ongoing work

WP 1 Technical and economic framework conditions for electric energy storage systems
(Leader: Dr. Bert Droste-Franke, Europäische Akademie, Germany)

- Preparation of some fact sheets for energy storage technologies i.e. Lithium, Lead Acid, Redox-Flow, Supercaps, CAES, Pumped Hydro, NaS, NaNiCl, Flywheel

- Survey on the power plant fleet evolution in European countries (see picture)



WP 2 Calculation method to determine spatial demand for electric energy storage (Leader: Dr. Yvonne Scholz, German Aerospace Center, Germany)

- Results on the spatial energy balancing demand in Germany as basis for the methodology which has to be developed.

WP 3 Applications of electric energy storage systems (Leader: Dr. Grietus Mulders, VITO, Belgium

- First survey on different applications of electric energy storages in different countries

WP 4 Requirements for test procedures (Leader: Dr. Marion Perrin, CEA-INES, France)

- Results from the DERRI project are adapted to this work package

<u>Meetings and workshops</u>

- (Kick-off Meeting, Germany, Oberhausen, 2010-Apr-08)
- (2nd Meeting, Spain, Barcelona, 2010-Oct-25)
- (3rd Meeting, France, Le-Bourget-du-Lac, 2011-Oct-19/20)
- 4th Meeting Spain, Lleida, 2012-May-14/15
- 5th Meeting Belgium, Mol, 2012-November-07
- 6th Meeting will take place in Germany, Stuttgart, 2013-April

Impression of the 5th Meeting in Belgium, Mol.

<u>Publications</u>

Bullinger, H.-J.; Doetsch, C.; Bretschneider, P. 2012, „Smart grids – the answer to the new challenges of energy logistics“ in CESifo Dice Report Journal for Institutional Comparisions; Volume 10, No. 3, pages 29-35; ISSN: 1612-0663; 2012

NEW ANNEXES

Annex 27 Quality Management in Design Constrution and Operation of Borehole Systems
The quality assurance issues included in the strategic plan of ECES is going to be addressed for borehole thermal energy storage systems in this annex.
Manfred REUSS - ZAE Bayern, Germany - reuss@muc.zae-bayern.de

Annex 29 Material Research and Development for Improved TES Systems

At the Executive Committee Meeting in Auckland, New Zealand, November 2012, this new Annex was approved. The objective of this joint Task with the IEA Solar Heating & Cooling Implementing Agreement is to continue the activities started in Annex 24 “Compact Thermal Energy Storage: Material Development for System Integration”.

From the experience of the experts in the first period of the Task, it was concluded that one strong point elaborated is the interaction between the materials experts and the application experts, and the facilitation of this interaction by the division of the work into two subtasks: materials and applications.

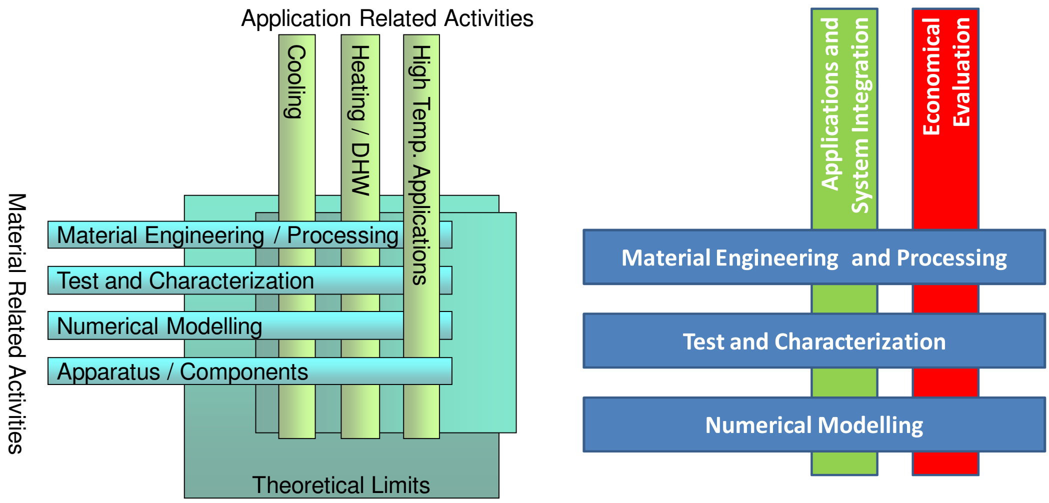


Figure 5: Old structure of Annex 24 (left) and proposed new structure (right).

The experiences of Annex 24 lead to the following new structure of the new Annex, depicted in
Figure 5. The matrix-like structure is maintained, with three materials working groups (in blue), one subtask for applications (in green) and one working group on economical evaluation (in red). The old working group on Apparatus and Component Design was stopped and the activities transferred to the applications subtask. Furthermore, the work in the former WG Theoretical Limits was narrowed

down to work on Economical Evaluation, as the deliverables for The oretical and Physical limits were discussed in Annex 24. The Applications and System Integration subtask is grouped as one, but the work is still subdivided into three working groups. This grouping, however, gives us the opportunity to also form other cross sections in this sub task.

The following Countries expressed their interest in participating in this new ECES activity:

Countries	Representing Institutes
Germany	ZAE Bayern
Germany	Fraunhofer ISE
France	University of Bordeaux
Japan	Chubu University
Slovenia	National Institute of Chemistry
Spain	University of Lleida
Sweden	Royal Institute of Techonology
Turkey	Cukurova University

The first Experts Meeting will take place in Freiburg, Germany, on April 15-17 2013.

Dr. Andreas Hauer,

Bavarian Center for Applied Energy Research, ZAE Bayern

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New Annex: Integration of Renewable Energies by distributed Energy Storage Systems

The contribution of renewable energy to overall global energy production is expected to grow worldwide. Most renewable energy sources, like wind, PV, and solar-thermal are fluctuating resources. Significant storage capacity is needed to smooth out these variable renewables for reliable future energy systems. At the moment the focus is on large, central energy storage technologies like pumped hydro or the conversion of surplus electricity into fuels such as hydrogen or methane. The potential for small, distributed energy storage technologies remains mostly unexplored.

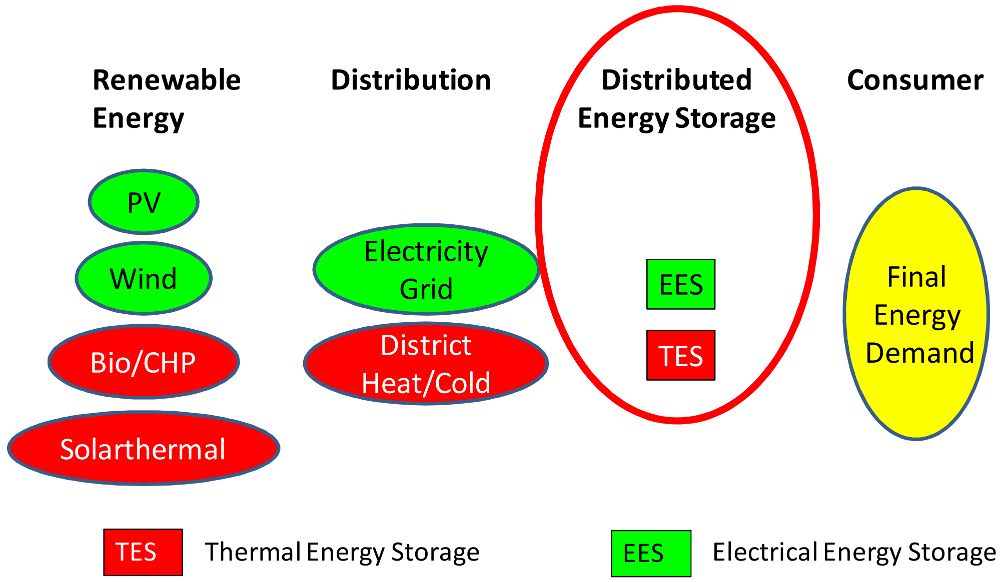

Figure 1: Definition of "distributed energy storages" by their position within an energy system.

The ECES is planning to start a new Annex on the "Integration of Renewable Energies by distributed Energy Storage Systems". This Annex should focus on the overall storage properties and their impact on the integration of renewable energy rather than the specific challenges of each energy storage technology. It will integrate electrical as well as thermal energy storage systems. Collaboration with other Implementing Agreements (IA) within the IEA Technology Network and other institutions active in the field of distributed energy storage is crucial for this Annex.

ECES organized a workshop in order to discuss the objectives, the scope, and the title of this Annex with all interested parties. At the same time the invited IAs and organizations were asked to present their activities in this context. The goal of the workshop was a better understanding of the ongoing R&D activities and the actual expertise both inside and outside of the IEA technology network. It took place in Paris on September 18/19 2012 and some 30 Participants from IEA, OECD and 7 Implementing Agreements attended.

It is planned to have a second workshop in Fall 2013, before the new Annex would start in January 2014.

Start: January 2014
End: December 2016

Andreas Hauer,

Bavarian Center for Applied Energy Research, ZAE Bayern
hauer@muc.zae-bayern.de

Further Activities

CONFERENCES

INNOSTOCK 2012

The 12th International Conference on Energy Storage was held in Leida, Spain, 16-18 May, 2012 (www.innostock2012.org). There was a special session on IEA during INNOSTOCK, with inputs from different ECBCS and HPP IAs and European Association for Storage of Energy. 239 papers including all energy storage topics (underground thermal energy storage, sensible, latent and thermochemical storage and electrical energy storage) were presented from 36 countries at the conference. Among the papers presented, the selected ones will be published in the special issue of Applied Energy Journal. Luisa Cabeza co-editor for this special edition presented the status of the review process.

GreenStock 2015

The next tri-annual conference, 13th International Conference on Energy Storage will be organized by China in Beijing. ECES delegates will participate in the International Scientific Committee. The status on preparation was presented by Zhang Shicong, alternate delegate for China.

EXECUTIVE COMMITTEE MEETINGS

The Executive Committee had two regular meetings during the year 2012. The 73rd Executive Committee Meeting in Leida, Spain on May 15 and the 74th XC Meeting in Auckland, New Zealand on November 29-30.

The most important items and decisions of the ExCo Meetings in 2012 are outlined below.

The Leida Meeting, May 15, 2012

- Approval of the minutes of the 72nd ExCo Meeting unanimously
- ExCo had the honour of having Mr.Carlos Lopez , the chair of EUWP. He presented the new EUWP strategy procedures and new IA reporting. He was impressed by the work done by ECES and stated that ECES will be a good example within EUWP since ECES contributes a lot to the technological advances on this field.
- Denmark and Slovenia joined the IEA ECES as a member, hence ECES has 18 contracting parties for the moment
- Niederland being a sponser member, is now going to become a member of ECES. ExCo agreed to invite NL and HP will send a letter of invitation.
- Philip Griffith from University of Ulster gave a brief information about the situation on UK membership. H. Paksoy will send a letter for exchange of contracting party.

- Report to EUWP must be sent to IEA
- Approval of the progress reports of the ongoing Annexes 21, 23, 24, 25 and 26.
- Discussion about the new Annex proposal: Annex 27 “Quality Management in Design, Construction and Operation of Borehole Systems”: This Annex aims to address the quality assurance of borehole thermal energy storage systems. ExCo accepted this new annex proposal
- Discussion about ‘‘Integration of Renewable Energies by Distributed Energy Storage systems . A. Hauer stated that other IA ‘s can contribute to this Annex.
- Discussion on the webpage status - more feed back and success stories from the operating agents are expected to improve the webpage.
- Discussion on preparation of Roadmap on Energy Storage. HP will inform the ExCo about feedback from IEA.
- Participation at SHC Conference for Buildings and Industry San Francisco USA 2012.
- Aart Sneiders will prepare a communication strategy paper to improve Communication and Impact in the Auckland meeting in the fall.

The Auckland meeting November 29-30, 2012

- Minutes of the 73rd EXCo Meeting were accepted.
- CERT approved the sponsor membership of Leida University from Spain .
- Josefine Wejerstrand is the new delegate of Sweden
- Tomasz Kuliche from Ministry Economics,Poland expressed interest of Poland to Joıin ECES İnformation on how to join the ECES was sent to him.
- Australia and New Zealand were invited to join ECES unanimously.
- ExCo elected Halime Paksoy as chair, Hunay Evliya as secretary and German delegate Hendrik Wust as vice chair for the year 2013
- The ExCo acting unanimity determined by written procedure, approved Annual Report 2011
- A new layout of Annual Report 2012 following IEA guidelines. An e-book format is decided to be available on the front page of the webpage.
- Approval of progress reports of the ongoing Annexes 23, 24, 25 and 26.
- Discussion about the new Annex proposal: Annex 27 “Quality Management in Design, Construction and Operation of Borehole Thermal Energy Storage’’ ExCo decided to ask Manfred Reuss to present the status on this new annex.
- A workshop was realized for task definition phase of the new Annex 28‘’ Integration of Renewable Energies by Distributed Energy Storage Systems” ExCo decided to ask A. Hauer to present a more detailed proposal ay the spring 2013 meeting.

- F.Haghighat presented a new annex idea on ''Integration of Energy Storage with NZEB which will be an annex to fill gaps in Strategic Plan. ExCo decided to ask FH to continue work on this and organize a workshop for scope definition.
- ExCo discussed the first draft on energy storage road map and ECES will be represented by one thermal(HP) and one electrical expert(CD). HP will participate in the teleconference for the steering committee on December 2012 and give comments from ECES ExCo.
- Discussion on to improve communication and impact: A communication strategy paper has been presented by Aart Sneiders. HP and AS will prepare a first draft on communication strategy paper and will share it with the delegates in Spring 2013.
- Discussion on the need to have an education activity: First concept for summer school will be prepared.
- Summary of the variety of conferences and workshop ECES attended in 2012 are IPHE Workshop, Sevilla, Spain, SHC Conference for Building and industry, San Francisco, USA and 2012 Innostock Conference Llieda Spain.
- ExCo decided to support the SHC Conference for Buildings and Industry in San Francisco, USA, July 9-11, 2012.

Co-ordination and Co-operation with Other IAs and Institutions

ECES is taking part in Building Coordination Group (BCG) and Electrical Coordination Group (ECG) of IEA. ECES has contributed to EGSE - Workshop and supported the NEET - activities. ECES has participated in the following IEA workshops to report on energy storage activities:

Participation at the EUWP Meeting Paris, 2012 where H. Paksoy presented ECES activities and received good reaction from EUWP chair and delegates

- There is an active joint annex with SHC IA: Task42/24 on Compact Thermal Energy Storage: Material Development for Systems Integration.
- ECES is also contributing to Storage Group within EC European Renewable Heating and Cooling Technology Platform - RHCTP. The 4th Annual Conference of RHCTP is in Dublin, 2013-04-11
- Fraunhofer Institute represented by the Operating Agent of Annex 26 has become a member of EASE
- Two upcoming ExCo Meetings: Spring 2013 Paris, April 25-26
  Fall 2013: Ljublijana December 4-5

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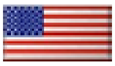

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International Energy Agency
Energy Conservation Through Energy Storage Programme

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