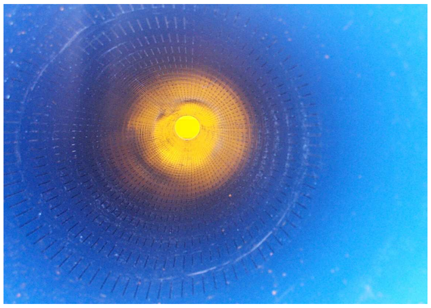
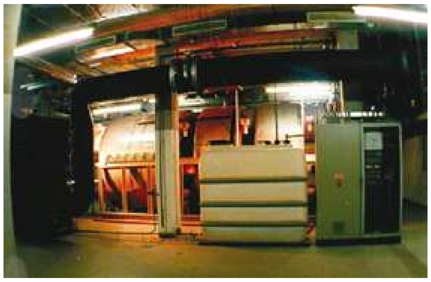
International Energy Agency

Energy Conservation through Energy Storage Programme





Annual Report 2010

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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, Finland, France, Germany, 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 Energesis Ingeniería, S.L. 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 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.

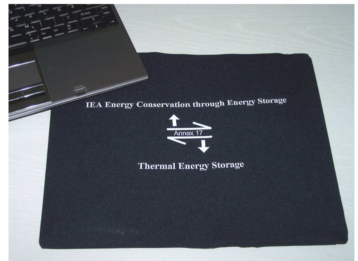
Market and Deployment: Develop and deliver information to support appropriate market deployment and provide effective collaboration and information to stakeholders.

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 form 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 black-outs 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

Storage technologies are one central component in every energy efficient system. The increase of energy efficiency in all sectors – building, industry, transport – is not possible without the increasing use of thermal as well as electrical storages. The increase of the Renewables is not possible either without using energy storages to balance the grid.
Public awareness of these basic sentences rose significantly in 2010, therefore energy storages are more and more accepted to play a key-role in future CO_2-reduction.
In addition the economic crisis has also demonstrated that economic aspects should be treated in parallel with energy questions. It is not enough to vigorously optimize energy systems, the economic benefit with respect to the payback time has to be calculated as well. Both the "green-image" and the monetary benefit are the arguments for any kind of climate protection to convince policy makers, industrial players and customers.
As these are the boundary conditions, scientific progress can´t ignore them. On the one hand, continuous R&D activities are necessary to develop optimised storage systems, on the other these systems have to enter the markets - otherwise they will not save energy at all.

Achievements in 2010

ECES achieved all targets set.
As a first example, two very important Annexes were started. Annex 25 is dealing with the use of surplus heat form industrial processes. Furthermore, the new Annex 26 carries out basic R&D activities to derive the energy storage demand beyond technical barriers as part of the total balancing demand, taking into account that the most successful economic solution will be chosen and put into practice.

Another important development was continued in 2010. As energy storage is a crosscutting issue, ECES strengthened the dialogue between the storage related Implementing Agreements and other relevant groups within the IEA.

After the first workshop regarding the role of energy storage in future energy systems in 2009, ECES organised a second workshop in Bad Tölz in 2010 with the title: "Energy Storage: Matching Supply and Demand in the Future".
Important results from this workshop were the need for structuring the knowledge and boundary conditions for different energy storage systems to enable optimal use in practise. Furthermore, the demand for best-practice examples were pointed out. Both aspects require to proceed with the storage coordination activities. In future these activities will be taken on by another group within the IEA beyond the more research-oriented Implementing Agreements to emphasize the significance of this topic.

The ECES-ExCo discussed a draft version at the spring meeting in Turku, where the ExCo enjoyed the hospitality of Finland.
Then the final version of the Strategies as well as the End of Term Report were sent to the IEA office. In September, the End of Term Report and the Strategies were presented at the meeting of the EUWP in Washington, in November at the CERT meeting in Paris. ECES successfully obtained the requested extension.

Furthermore, ECES is proud to welcome China as a new member country. Hence the fall meeting took place in Shanghai, China. The ECES-ExCo were very impressed by the Chinese development in this extremely impressive city. Thanks again to the Chinese delegates for arranging this impressive meeting.

Overall 2010 was a very successful and interesting year for ECES.

At the fall meeting the election of the new chair and secretary took place: Halime Paksoy (chair) and Hunay Evliya (secretary) were elected.

Support by the IEA-Secretariat
I would like to take the opportunity and thank all colleagues for their continuous efforts and engagement in particular our IEA desk officer Steven Lee and Dr. Andreas Hauer (ECES scientific secretary). Finally I would like to wish our Turkish team all the best for the interesting times which lie ahead.

Dr. Astrid Wille

Astrid Wille, Chairman ECES

Ongoing Activities

In 2010 5 Annexes were performed by the "Energy Conservation through Energy Storage" Implementing Agreement.

Annex-No.	Title	Time Schedule	Operating Agent
21	Thermal Response Test	2007-2010	ZAE Bayern/ Germany
23	Applying Energy Storage in Buildings of the Future	2009-2012	Concordia University/Canada
24	Compact Thermal Energy Storage: Material Development for System Integration	2009-2012	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 21: Thermal Response Test

Thermal Response Test (TRT) is a measurement method to determine in situ ground thermal properties i.e. effective thermal conductivity of ground thermal resistance in boreholes. This is important for the design of Underground Thermal Energy Storages (UTES). The TRT equipment is usually set up on a trailer for easy transportation between test sites. This method has been very important in the rapid spreading of BTES systems. It has been a door opener for introducing this technology in "new" countries.

The overall objectives of Annex 21 are to compile TRT experiences worldwide in order to identify problems, carry out further development, disseminate gained knowledge and promote the technology. Based on the overview a TRT state-of-the-art, new developments and further work are studied.

Annex 21 was approved by the Executive Committee in April 2007, scheduled to run until April 2011 and at the Executive Committee Meeting in November 2010 extended until October 2011. Operating Agent is the Bavarian Center for Applied Energy Research, ZAE Bayern, Germany. Participating Countries: Germany, Sweden, Canada, Finland, Japan, Korea, Norway, Spain, Italy, Turkey and The Netherlands. Several other countries like Austria, Bulgaria, UK and USA have shown interest and attended some of the meetings as observers. Most of the interested institutions were not able to join due to lack of funding.

Activities 2010

The spring meeting was hosted by the University of Bologna in Italy sponsored by the company GEO-NET and the region Emilia-Romagna. Shallow geothermal systems and along with them Thermal Response Testing is fast growing in Italy. The second meeting in 2010 and tentative last one was held in Espoo, Finland hosted by the Geological Survey of Finland GTK.

In 2010 the data collection for the state-of-the-art-study of subtask 1 was still going on. Germany turned out to be one of the countries with the highest number of running TRT equipments. More than 20 companies, tendency growing, provide TRT measurements. Several of them are running more than one test rig. In most of the other countries only few companies offer the TRT for site investigation.

In subtask 2 'New Developments' one item of discussion was the determination of undisturbed ground temperature and its vertical profile by different measurement methods such as a submersible data logger, optical fibre, measurements by fluid purging and lowering of temperature sensors in the borehole heat exchanger (BHE) pipes. Ground water influence with a resulting convective heat transport on TRT is investigated in Norway and Germany in research projects. Further subjects like TRT while drilling, TRT for heat pipes, TRT for special geometries of BHEs like energy piles and the pulse test were discussed. All available information was collected and summarized in a first draft of the subtask report.

Common evaluation models for TRT (and also models for system design) as reported in subtask 3 'Evaluation Methods and Developments' do not consider ground water influence. Measurements show significant different results for □eff with and without *ground water influence (Fig. 1, Fig. 2). The convergence of the measured thermal conductivity with time can be used as criterion for the validity of the evaluation.*

For the 'Standard TRT Procedures' (subtask 4) the description of the correct evaluation time period (minimum time criterion and measurement period) is still under discussion and requires for further clarification a re-evaluation of tests of the Annex members. The German VDI 4640 guideline committee has decided to use the outcome of this subtask as basis for the new VDI 4640 part 5 'Thermal Response Test'.

The main activity of subtask 5 the TRT website was again revised by the members and is now online at www.thermalresponsetest.org.

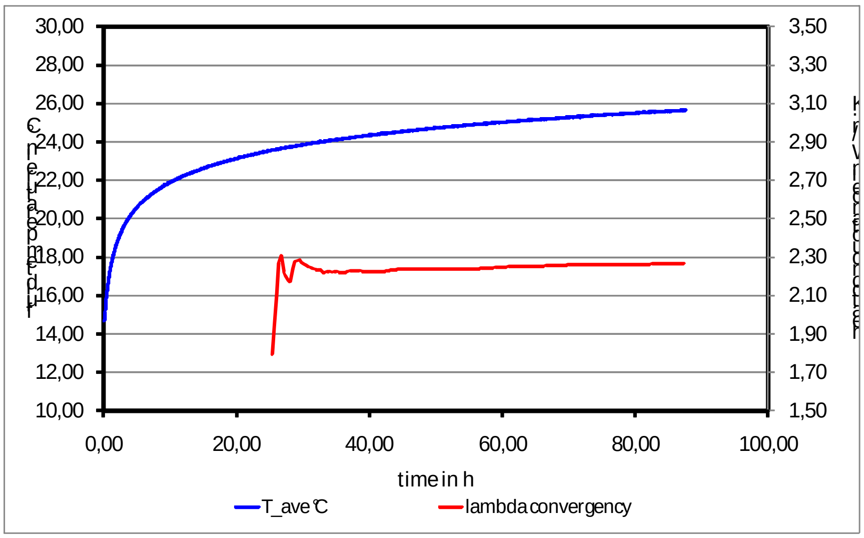
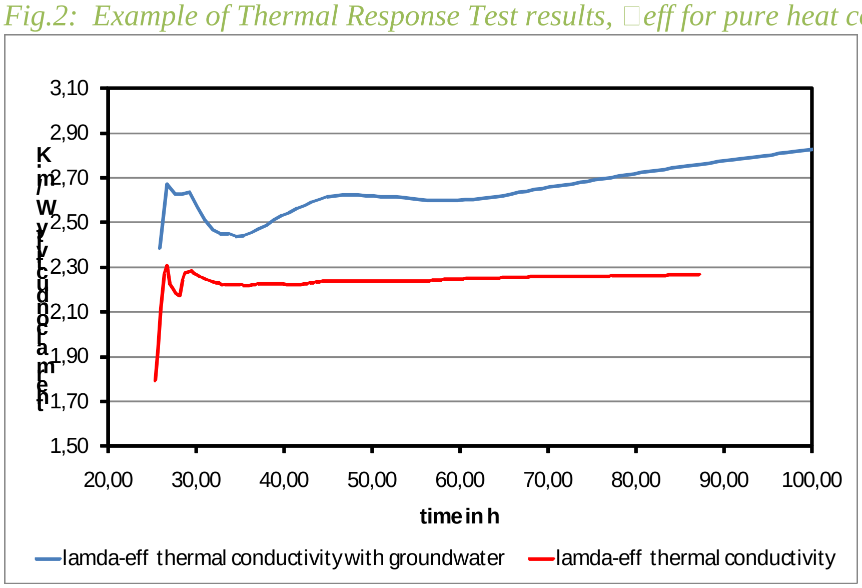


Fig.1: Thermal Response Test result for pure heat conduction. Temperature response with time (blue curve), the □eff-value (red curve) shows convergence with increasing time of measurement

Fig.2: Example of Thermal Response Test results, □eff for pure heat conduction (red



curve) and with ground water influence (blue curve). In case of ground water □eff does not converge and can't be used for design with regular heat conduction models.

Future Activities

At the moment no further expert's meetings are planned. The major activity will be the compilation of the final report as the Annex will end in 2011.It will be based on the final report of the five subtasks.

Contact

Manfred REUSS – ZAE Bayern, Germany – reuss@muc.zae-bayern.de

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Annex 23: Applying Energy Storage in Buildings of the Future

Sustainable buildings will need to be energy efficient well beyond current levels of energy use. They will need to take advantage of renewable and waste energy to approach ultra-low energy buildings. Such buildings will need to apply thermal and electrical energy storage techniques customized for smaller loads, more distributed electrical sources and community based thermal sources. Lower exergy heating and cooling sources will be more common.

The general objective of the Annex is to ensure that energy storage techniques are properly applied in ultra-low energy buildings and communities. Applications of these designs are foreseen in recent years where total carbon dioxide reduction is required. Proper application of energy storage is expected to increase the likelihood of sustainable building technologies and may well be necessary for the wide scale adoption of sustainable buildings.

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*

To reach these objectives, the annex is structured in five subtasks.

Subtask A: Coordinated national reviews of energy storage use in energy efficient buildings

The subtask will focus on a coordinated review of energy storage use in each participating country. The review will include the performance assessment, the advantages, requirements and limitations. The subtask will focus on systems that have the potential to be used for monitoring in Subtask D.

Subtask B: Evaluate energy storage usage and proposed efficient systems based on Subtask A and other Annex results

The subtask will focus on carrying out an extensive literature review to study the existing techniques to evaluate the performance of these systems in order to develop a common evaluation technique for comparison of different energy storages. This procedure will be used to investigate the performance of systems from Subtask A.

Subtask C: Develop sustainable energy storage designs for a variety of ultra-low energy buildings using thermal, phase change materials and electrical storage options

The focus of this subtask is to develop new sustainable energy storage or improve promising existing systems that have potentials to be successfully integrated with a variety of ultra-low energy buildings.

Subtask D: Apply, monitor and evaluate demonstrations of these designs in a number of countries and climates

The focus of this exercise is to collect reliable data from a number of demonstration projects. The collected data will be used to study the performance of the system and will be also used by other participants for model verification.

Subtask E: Identify technologies and applications needed in the long-term to achieve 2030 building objectives and develop typical sustainable energy storage designs

The concentration of this subtask is to evaluate and analyze the information obtain from previous subtasks to identify technologies to achieve the objective of this Annex.

The second expert meeting was held in Lyon-France in March 2010 where the first Forum was held and the goal was to disseminate information and provide an opportunity for discussion among participants, as well as to get feedback on the Annex work plan. Over sixty participants attended the meeting: there were a total of 12 presentations,

The third Annex meeting was held in conjunction with the PALENC 2010 meeting. A special session entitled "Phase Change Materials as a Tool towards Low Energy Building" was organized at this international meeting. A total of 8 papers dealing with the application of PCM in the design of an energy efficient and thermally comfortable building were included in this session. Over fifty participants attend this session.

At this meeting the Subtask A leader reported the preliminary outcomes of survey which includes 15 case studies. He emphasized that the survey is incomplete. This incompleteness makes it impossible to draw conclusions about actual implementations either in the laboratories or as demonstration buildings. Therefore, it is not possible to create a meaningful database of storage application. Nevertheless, from the presented results we can discern a trend that would need to be confirmed that is most projects tend to be intended to manage the demand (diminish peak power consumption).

In many case, utilization of PCM bears economic interest only if one takes into account the change of energy cost through the day. In addition, since these gains are compared to a standard building, they cannot be easily compared to high performance designs. He then mentioned that it is very difficult to extract general design rules or even simple practical results from the scientific literature. This problem arises from the fact that there is almost no inter-comparison between various designs. In most studies, the optimization of a single particular configuration is studied. Even for models, each group tends to use its own in-house solution without systematic comparisons with *others. In addition, performances of energy storage systems are strongly related to local climatic conditions, which add to the difficulty of the reutilization of previously published results in subsequent research as a comparison basis. However that may be, the actual size of the survey makes such comparison impossible.*

It was recognized that there is a strong need for a comprehensive validation of the existing simulation programs with respect to modelling of the passive thermal storage (PCM, TCM, sensible), development of a model for TCM simulation, and LCA. This is needed to ensure the development of medium-term Sustainable Energy Storage Designs for a variety of ultra-low energy buildings. Therefore energy storage designs for a variety of building types will be examined depending on the interests of the participants.

It was agreed that conceptual designs of ultra-low energy building types with energy storage recommendations will be developed based on case studies. Case studies will be performed by means of simulation tools. Each participant having their own simulation tools, a comprehensive validation of the existing simulation programs with respect to modeling of the passive TES will be carried out. The numerical models will be validated by means of experimental results provided by the task D.

Operating Agent

Canada

Participating Countries

Brazil (Associate Member), Canada, China, France, Greece (Associate Member), New Zealand (not confirmed), Norway, Spain, Sweden, Turkey, UK.

Contact

Fariborz HAGHIGHAT - Concordia University - Montreal, Quebec Canada - haghi@bcee.concordia.ca

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

From past IEA SHC and ECES tasks it was concluded that a broad and basic research and development initiative is needed to find and improve compact thermal energy storage materials. The IEA joint Task/Annex 42/24 brings together experts from both the materials development field and the systems integration fields. In four years, the task aims at having finished the first steps towards a new generation of thermal storage technologies.

In 2010 two expert meetings were held. The third expert meeting in Bordeaux was held in July. In this meeting it became also clear that the System Integration aspects were dealt with in both the System Integration working group and in the three Application working groups. A new discussion on the Task structure lead to the conclusion to stop the System Integration working group. The altered Task structure is described below.

	Materials:	*WG Leader*
WGA1	*Material Engineering and Processing*	*Elena Palomo (Univ.Bordeaux, FR)*
WGA2	*Test and Characterization*	*Stefan Gschwander (ISE, DE)*
WGA3	*Numerical Modelling*	*Camilo Rindt (TUE, NL)*
WGA4	*Apparatus and Components*	*Wim van Helden (a.i.) (ECN, NL)*

	Applications:	
WGB1	*Cooling (0 °C – 20 °C)*	*Motoi Yamaha (Chubu Univ, JP)*
WGB2	*Heating / DHW (20 °C – 100°C)*	*Jane Davidson (Univ.Minnesota, US)*
WGB3	*High Temp. Appl. (> 100 °C)*	*Luisa Cabeza (Univ.Lleida, ES)*

	Cross Cutting:	
WGC1	*Theoretical Limits*	*Eva Günther (ZAE Bayern, DE)*

The Graz expert meeting was held just prior to the Eurosun conference. There was a very good representation of Task4224 related publications at the two oral sessions and poster session dedicated to Thermal Energy Storage at Eurosun. Both the Bordeaux and Graz meeting were well attended.
In the different Working Groups (WG) quite remarkable progress was achieved:

- *Materials engineering and processing: The decision was made to start with a materials database, and incorporate safety data. The materials data will be supplied by all experts. A short report on the micro-encapsulation of inorganic PCM ͨs was finished in concept. Samples of newly synthesised zeolites and composites were made and sent to other institutes for characterisation.*
- *Materials testing and Characterisation: The first comparison was made of the round-robin test of different PCM samples. There are considerable differences in the measured values. The round-robin will be completed (also including sorption materials) and the results used to make a proposal for a normalised testing procedure.*

- *Numerical Modelling: A first draft of the report describing numerical modelling techniques was finished.*
- *Apparatus and Components: A mind map was produced describing all the aspects of the design process for a thermal storage. The design process was divided into consecutive steps.*
- *Cooling Applications: A schematic overview of available cold storage applications examples was made, in the temperature range from -40 °C to 40 °C.*
- *Heating and Domestic Hot Water Applications: An overview was made of the Task experts that are doing performance simulations for either technical performance, economical performance or that can provide experience from prototype testing.*
- *High-temperature Storage: Three different application fields have been identified. The first is high-temperature waste heat utilisation from industrial processes, e.g. steel industry. Second is thermal energy storages for process heat. Third is thermal energy storage for concentrated solar power plants.*
- *Theoretical Limits: A study into the physical limits of thermal storage was drafted. An inventory was made of the different ways to categorise a storage system.*

Figure 1: Test cubicles for comparing experiments of thermal energy storage materials for passive cooling (University of Lleida, Spain)

Operating Agent

Germany

Participating Countries

Austria, Australia, Belgium, Canada, Denmark, Japan, New Zealand, Switzerland, Germany, Spain, France, The Netherlands, Sweden, Turkey, UK, USA.

Contact

Andreas HAUER – ZAE Bayern – hauer@muc.zae-bayern.de

Future Activities

20.2.2011, Experts Meeting in Belfast, UK (in connection with the Sustainable Energy Storage Conference 2011)

September 2011, Experts Meeting and Workshop, University of Minnesota, USA

Presentations

In 2010 presentations about the Task4224 and its work has been given at:

- *Intersolar Solar Thermal Conference, Munich, Germany, 9 June 2010*
- *ASME conference, San Francisco, USA, July 2009*

A key note lecture has been given at the EuroSun Conference September 2010 in Graz, Austria by the Operating Agent

Publications

Castellón C, Medrano M, Roca J, Cabeza LF, Navarro ME, Fernández AI, Lázaro A, Zalba B, Effect of microencapsulated phase change material in sandwich panels Renewable Energy, 35, 2370-2374, 2010

Fernández AI, Martínez M, Segarra M, Martorell I, Cabeza LF Selection of materials with potential in sensible thermal energy storage Solar Energy Materials and Solar Cells, 94, 1723-1729, 2010

Gil A, Medrano M, Martorell I, Lázaro A, Dolado P, Zalba B, Cabeza LF State of the art on high temperature thermal energy storage for power generation. Part 1-Concepts, materials and modellization, Renewable & Sustainable Energy Reviews, 14, 31-55, 2010

Castell A, Medrano M, Martorell I, Pérez G, Cabeza LF Experimental study of using PCM in brick constructive solutions for passive cooling Energy and Buildings, 42, 534-540, 2010

Ristić, A., Kaučič, V., A novel sorption material for thermal energy storage, First international conference on materials for energy, July 4-8, 2010, Karlsruhe, Germany.

Ristić, A., Henninger, S.K., Zabukovec Logar, N. Kaučič, V., Novel Adsorption Material for Thermal Energy Storage,, EuroSun 2010, International Conference on Solar Heating, Cooling and Buildings, 28.9.-1.10.2010, Graz, Austria.

D. Katsourinis, M. Founti, M.D. Romero Sánchez, A.M. López Buendía On The Computational M0delling of Thermal Energy Storage in Natura Stone Treated with PCMs, IIR Proceedings Series "Refrigeration Science and Technology". 9th Int. Conference on Phase-Change Materials and Slurries for Refrigeration and Air conditioning. 29 Sept-1 Oct 2010. Sofia. Bulgaria. ISBN: 978-2-913149-82-3; ISSN: 0151-1637

Peñalosa, C., Lazaro, A., Delgado, M., Zalba, B. 2010, Looking for "low cost" Phase Change Materials and their application for energy saving. EuroSun 2010 Conference proceedings, Graz (Austria), 28 September - 1 October 2010.

Robert Weber, Langzeit- Wärmespeicherung mit NaOH, Aktiv Solarhaustagung Luzern, 22./23. 09. 2010

Robert Weber, Heat storage with Sodium Hydroxide, EuroSun 2010, Graz, 28. 09. - 01. 10. 2010

Quinnell, J. A., Davidson, J. H., Burch, J., "Liquid Calcium Chloride Storage: Concept and Analysis," ASME 2010 4th Annual Energy Sustainability Conference, May 17-22, Phoenix, AZ.

Annex 25: Surplus Heat Management using Advanced Thermal Energy Storage Technology

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 distribu-tion.*
- *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 utili-zation issue from a very broad perspective and show the great potential for us-ing 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 (ba-sic research to commercial systems).

In 2010, the kick-off meeting of the Annex was held in Lleida (Spain) 7-8.10.2010. 12 participants from 7 countries attended the meeting. The main ob-jective of the meeting was the revision of the participants contribution (12 pro-ject were presented by the participants), and the revision of the sub-tasks, which were defined as:

- *Advanced TES in process integration and district distribution*

Subtask leader: Michael Himpel (ZAE Bayern, Germany)

- *Advanced TES in surplus heat driven power*

Subtask leader: Xavier Py (PROMES-UPVD, France)

- *Advanced TES in vehicles*

Subtask leader: Yukitaka Kato (Tokio IT, Japan)

- *Advanced TES for cooling (LNG, solar cooling, etc)*

Subtask leader: Luisa F. Cabeza (UdL, Spain)

- *Environomical performance assessment*

Subtask leader: Viktoria Martin (KTH, Sweden)

Figure 2: New materials developed from industrial wastes for solar power storage systems (PROMES, Perpignan)

Future Activities

11-12.4.2011, 2nd Workshop & Experts Meeting in Perpignan (France)

October 2011, 3rd Workshop & Experts Meeting, Japan

14-15.5.2012, 4th Experts Meeting, Lleida (Spain), in conjunction with Innostock 2012

Operating Agent

University of Lleida, Spain

Participating Countries

Spain, Sweden, France, Japan, Germany, New Zealand, China.

Contact

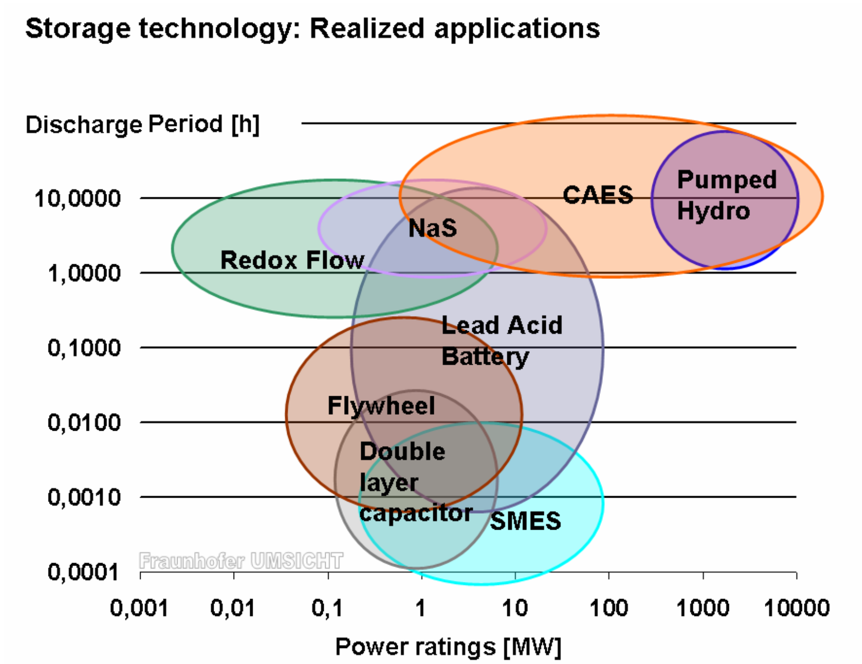
Luisa F. CABEZA - University of Lleida.- lcabeza@diei.udl.cat

Selected publications

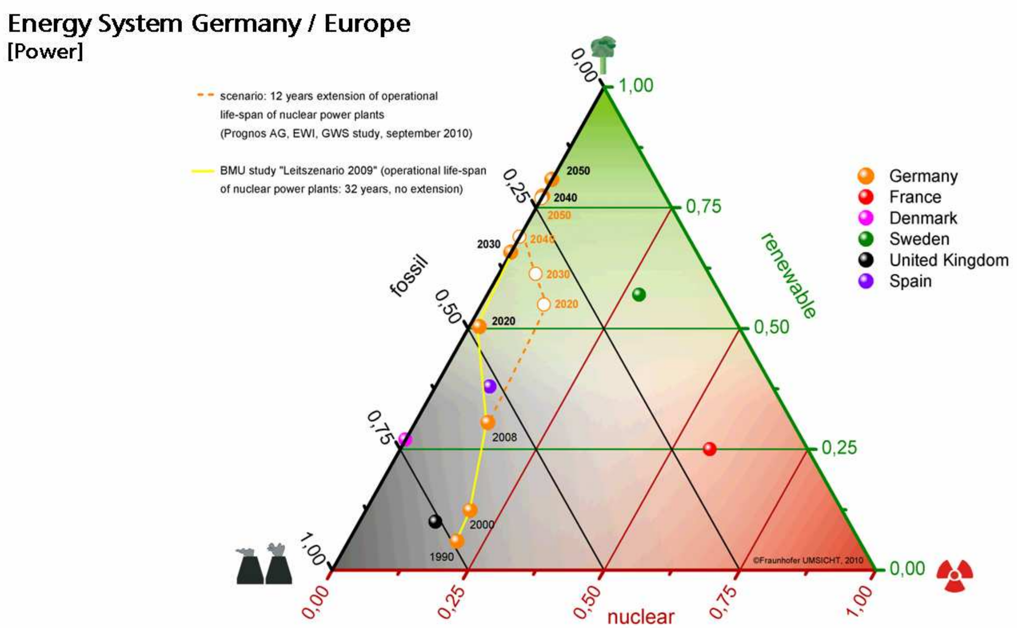
Fernández AI, Martínez M, Segarra M, Martorell I, Cabeza LF, Selection of materials with potential in sensible thermal energy storage, Solar En-ergy Materials and Solar Cells, 94, 1723-1729, 2010

Annex 26: Electric Energy Storage: Future Energy Storage Demand

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.



Survey about different storage technologies (>100 kW) realized in the world



Survey about power plant fleet in some European countries and the development in Germany

The main objectives of Annex 26 are:

- *survey about technologies, framework conditions and applications*
- *calculation methodology to determine spatial energy balancing demand*
- *outlook on future applications and test procedures*

To reach these objectives, the annex is structured in four main work packages

I. Technical and economic framework conditions for energy storage systems

The aim is to give an assessment and a comparison about general technical and economical conditions in the different countries. Therefore a survey about realized storage systems, national technical key figures with their future development and economic framework conditions have to be examined.

II. Calculation method to determine spatial demand for electric energy storage

In this core work package a new, spatial mathematical method has to be developed and applied to different "worlds" to derive the grid balancing demand and the energy storage demand as a part of it.

III. Applications of electric energy storage systems

In this work package realized and future applications of electric energy storage will be examined to derive business cases and to compare them with real case studies. Last but not least smart grid technologies, which are competing technologies, are taken into account.

IV. Requirements for test procedures

The aim of this work package is to develop guidelines – derived from applications – for testing energy storage systems.

The kick-off meeting was held in June 2010 in Oberhausen (Germany) and the goal was to discuss among participants, as well as to get feedback on the Annex work plan. Over 20 participants attend the meeting and 17 presentations were given.

Impressions of the kick-off meeting 8th and 9th of June 2010.

The second meeting was held in October 2010 in Barcelona (Spain) joined with an international storage conference. This was a meeting of a core group of 12 people to discuss who will be in charge of the different work packages and what technologies will be taken into account. The next meeting is planned at INES in France in 2011.

Publications

Schnur, A.; Kanngießer, A. 2010, „Energy balancing demand - how much is needed and where?“ Poster, 5th International Renewable Energy Storage Conference, IRES 2010. CD-ROM : 22.-24. November 2010, Berlin, SEMINARIS CampusHotel Berlin, Science & Conference Center

Bonn: EUROSOLAR, 2010

Operating Agent

Fraunhofer UMSICHT, Germany

Contact

Christian DOETSCH - Fraunhofer Umsicht, Germany – christian.doetsch@umsicht.fraunhofer.de

Further Activities

Executive Committee Meetings

The Executive Committee had two regular meetings during the year 2010. The 69th Executive Committee Meeting in Turku, Finland on May 20-21 and the 70th XC Meeting in Shaghai, China on November 25-26.

The most important items and decisions of the XC Meetings in 2010 are outlined below.

The Turku, Finland Meeting, May 20-21, 2010

- *Approval of the minutes of the 66th XC Meeting.*
- *Astrid Wille (Germany) was unanimously elected as Chairman, Halime Paksoy (Turkey) and Lynn Stiles (USA) were elected as Vice Chairs.*
- *XC decided to invite Energesis Ingeniería, S.L. (Spain) as a sponsor and China to become a contracting party.*
- *XC decided to write a letter to "dormant" participating countries and to take them from the list of active members in case they will not reply before the next ExCo Meeting. The legal office requires to state only active participants.*
- *XC decided unanimously to apply for an extension, the new chair Astrid Wille will be responsible to prepare and finalize the end of term report and the new strategy plan. A first proposal will be distributed before the autumn XC Meeting.*
- *Approval of the progress reports of the ongoing Annexes 18, 19, 20 and 21.*
- *Discussion on the planned workshop "The Role of Energy Storage in Future Energy Systems". The idea behind this workshop to start a better coordination of storage related activities between the relevant Implementing Agreements.*
- *Discussion on topics for potential Annexes on electrical storages: Batteries and Fuel Cells, Electric Vehicles and Standardization, Grids of the Future and State of the art report concerning all types of storages. Each country will try to identify special items and experts for an IEA collaboration.*
- *The progress of the organization of the Effstock conference 2009 in Stockholm was presented, the program and contribution of ECES was discussed in detail.*

The Shaghai, China, Meeting, November 25-26,2010

- *Minutes of the 67th XC Meeting were accepted.*
- *Progress report about the very promising contracting process of China; the process for the new sponsor from Spain is nearly finished, only the CERT approval is missing.*
- *Approval of progress reports of the ongoing Annexes 18, 19, 20, 21, 22 and 23.*
- *Discussion about two new Annex proposals: Annex 25 is about "Surplus Heat Management using Advanced TES for CO2 Mitigation", Annex 26 deals with the "Electric Energy Storage: Future Energy Storage Demand".*
- *The progress of the organization of the planned "Innostock" conference 2012 in Lleida (Spain) was presented in combination with a discussion about the related rules.*
- *Summary of the variety of conferences and workshop ECES attended in 2009, one highlight was the Effstock Conference in June.*
- *Discussion about the results from the workshop "The Role of Energy Storage in Future Energy Systems": There was a strong reaction in favor of a "Storage Coordination Group". ECES will prepare the next steps in close contact with the IEA office and CERT. The workshop was very successful and very well received by all participants.*
- *Discussion about the Energy Saving Potential of Thermal Energy Storages. Spain is in progress to calculate the relevant data for the EU and for Spain specifically. The shown table was very helpful to increase the visibility of energy storage potential in general and will lead to a better understanding of policy makers and industry for the benefit of energy storages.*
- *ECES will assist in the organization of expert workshops on the application of thermal energy storages in buildings. A contribution to the ETP 2010 and a book on energy efficient buildings is planned.*
- *The XC decided to have a joint meeting with the SHC-IA in 2011 in Europe.*

Other Activities

"Energy Storage: Matching the Supply and Demand in Future"

Workshop, 14th -16th July 2010, Bad Tölz, Germany

Scope of the Workshop

The Implementing Agreement "Energy Conservation through Energy Storage" (ECES) organized a second workshop on the future role of energy storage. This workshop took place from July 14th until 16th, 2010 in Bad Tölz, Germany.

The initial meeting with representatives from Implementing Agreements, EUWP, REWP and CERT in 2009 established that the main focus should be put on coordinating *activities in the field of energy storage as a cross-cutting issue. This is due to the fact that energy storage bridges the gap from the power supply resp. the Renewables to all end use sectors. Furthermore storages are also very important for the distribution system.*

The participants decided to continue with the process of coordinating further research activities on energy storage within the IEA and work out the main topics and suitable ways of cooperation for each one. This was the reason for a second workshop where experts from the above mentioned sectors as well as from within the IEA framework were invited.

Different views on energy storage – their potential as well as their limits – were discussed during the workshop. Also key issues and suitable ways of collaboration were discussed. These results of these discussions as well as the next steps are outlined in detail below.

As energy storage is the linchpin for the integration of Renewables in future and increasing energy efficiency in all energy systems, CERT supports this ECES initiative.

Participation

The organisation of the workshop was supported by the Committee for Energy Research & Technologies CERT. Peter Cunz, Chair of CERT, Hermann Halozan, Chair of EUWP and the Irish delegate of REWP were participating the meeting.

The following Implementing Agreements sent their representative to the workshop:

- *Ocean Energy Systems (OES)*
- *District Heating and Cooling (DHC)*
- *Greenhouse Gas (GHG)*
- *Solar Heating and Cooling (SHC)*
- *Photovoltaic Power Systems Programme (PVPS)*
- *Demand Side Management (DSM)*
- *Industrial Energy-Related Technology and Systems (IETS)*
- *Energy Technology Systems Analysis Programme (ETSAP)*
- *Energy Conservation through Energy Storage (ECES)*
- *Solar Power and Chemical Energy Systems (SolarPACES)*
- *Heat Pump Programme (HPP)*
- *Electricity Networks Analysis, R&D (ENARD)*

All presentations as well as the agenda of the workshop are available on the ECES webpage.

Summary of Workshop

The leading question of the workshop was "Do you need energy storage?". Presentations given by the Implementing Agreements at this workshop highlighted the *individual energy storage needs. The following discussion made clear that it would be very valuable to have a characterisation of the different storage demands in order to identify a suitable storage technology. The characterisation should follow the list of energy storage properties: Storage capacity (kWh/kg, kWh/m³), charging/discharging power (W/kg, W/m³), storage efficiency, storage period (time), price (€/kWh, €/kW) and storage cycles (per year, day…). Important for the economical evaluation is the question of competing technologies. What are alternative solutions concerning the storage technology itself and also concerning the complete energy systems. For example in the case of concentrated solar power (CSP) the energy can be stored as thermal energy to allow a continuous electricity production. Storage of electrical energy seems not to be an interesting alternative. Concerning complete system technologies like PV or CCS power plants could be an alternative.*

It was decided to provide templates to all relevant Implementing Agreements and to ask them to fill in their energy storage requirements and boundary conditions. The results will be the basis discussion for the next meeting of this group. At this meeting the question will be "What kind of energy storage do you need?". The result could be the identification of suitable storage technologies and possible synergies as well as better focussed R&D activities and fruitful collaboration among the IAs. The next workshop is planned for the end of January 2011.

An estimation of the future application potentials for the visibility of energy storage technologies is most important. This can come from national or international energy scenarios, which allows calculating an overall storage demand. However, this has to be subdivided further into electrical/thermal, central/distributed, high/low power output or long/short term energy storages. It was proposed to start a joint Annex activity by the ECES and the ETSAP IA.

The participants agreed on the need for future cooperation between the different Implementing Agreements. Therefore one output of the workshop was titled "Concept Development and best practice" and can be described as follows. The main idea is to develop a best-case scenario for a storage-based system using Renewables in the most efficient way for a real situation in an emerging country and to realize this in a demonstration project.
In order to reach this ambitious goal a strong exchange between the Experts from the relevant IAs and the different levels within the IEA is necessary. The Technology Platform could play an important role to enhance the dialogue between Representatives form the emerging countries, investors, political decision makers and IEA experts.

The plan was approved to develop an energy system concept for a simplified situation based on a real situation. This so-called "virtual concept" will form the basis for a first workshop in the frame of the Technology Platform. This concept should demonstrate the expertise of the IA experts and has to be the starting point to identify a real situation in an interested country, e.g. non-IEA country.

In the next phase the boundary conditions and the specific demand and supply situation have to be analyzed from the IA experts together with national representatives. After *that a best-case concept with regard to the maximum integration of Renewables has to be worked out. This concept has to be presented at a second workshop in the Technology Platform to convince the representatives from the business and investor sector as well as the policy makers and the national experts from the addressed country.*

In a best-case scenario the developed concept could be put into practice afterwards. Within the workshop all IAs as well as the Representatives from CERT and the Working Parties agreed to this proposal which can be summarized as follows, including a first approach for the time-schedule:

Next Steps 2/2

▪ Correspondence with Techn. Platform	ECES	Until Sept. 2010
▪ Developping virtual concept	**ECES** Other IAs	Until June 2011
▪ Organising workshop within the Techn. Platform	**IEA/ECES** Other IAs	Until Nov. 2011
▪ Developping real concept	**ECES** Other IAs	Until June 2012
▪ Organising workshop within the Techn. Platform	**IEA/ECES** Other IAs	Until Nov. 2012
▪ Starting demonstration phase	All	Starting 2013

Executive Committee Members

Belgium

Delegate

Bert Gysen
Vlaamse Instelling voor Technologisch Onderzoek, VITO
Boeretang 200
B-2400 Mol
BELGIUM
Tel.: +32 14 335 914 (5511)
Fax: +32 14 321 185
bert.gysen@vito.be

Canada

Delegate

Edward Morofsky
Public Works and Government Services Canada
Place du Portage, Phase III, 8B1
Gatineau, Quebec K1A 0S5
CANADA
Tel.: +1 819 956 3419
Fax: +1 819 956 3875
Ed.Morofsky@pwgsc.gc.ca

Alt. Delegate

Frank Cruickshanks
Environmental Protection & Operations Directorate
Climate Change Section
45 Alderney Drive, Dartmouth
Nova Scotia B2Y 2N6
CANADA
Tel.: +1 902 426 6885
BB: +1 902 425 1731
Fax: +1 902 426 4457
Frank.Cruickshanks@ec.gc.ca

China

Delegate

Xu Wei,
China Academy of Building Research -CABR
30# Beisanhuandonglu, ChaoYang District, Beijing
CHINA 100013
Tel: +86-10-8427-0105
Fax: +86-10-8428-3555
xuwei19@126.com

Alt. Delegate

Zhang ShiCong,
China Academy of Building Research -CABR
30# Beisanhuandonglu, ChaoYang District, Beijing
CHINA 100013
Tel: +8610- 84270181

Fax: +8610-84283555
zsc2062198@yahoo.com.cn

Finland

Delegate

Juha Linden
Energy and Environment National Technology Agency of Finland (TE-KES)
Kyllikinportti 2
P.O. Box 69
FIN-00101 Helsinki
FINLAND
Tel.: +358 40 5681795
Fax: +358 20 7227026
juha.linden@tekes.fi

Alt. Delegate

Raili Alanen
VTT Energy and P&P
Tekniikantie 2, Espoo
P.O.Box 1000
FIN-02044 VTT,
FINLAND
Tel.: +358 20 722 5808
Fax: +358 20 722 7026
Raili.Alanen@vtt.fi

France

Delegate

Elena Paloma del Barrio
Universités Laboratoire TREFLE/CNRS
UMR 8508
Esplanade des Arts et Métiers
F-33405 TALENCE cedex
FRANCE
Tel.: +33 5 56 84 54 04
elena.palomo@bordeaux.ensam.fr

Alt. Delegate

Eric Peirano
Département "Energie Renouvellable"
ADEME
500 route des Lucioles
F-06560 Sophia-Antipolis
FRANCE
Tel.: +33 4 93 95 79 34
eric.peirano@ademe.fr

Germany

Chair

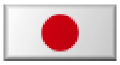
Astrid Wille
Project Management Jülich
Division Energy Technologies
Forschungszentrum Jülich GmbH
D-52425 Jülich

GERMANY
Tel.: +49 2461 61 2712
Fax: +49 2461 61 3131
a.wille@fz-juelich.de

Alt. Delegate

Rolf Stricker
Project Management Jülich
Division Energy Technologies
Forschungszentrum Jülich GmbH
D-52425 Jülich
GERMANY
Tel.: +49 2461 61 1575
Fax. +49 2461 61 3131
r.stricker@fz-juelich.de

Japan



Delegate

Tadahiko Ibamoto
Tokyo Denki University
2-2, Kanda-Nishiki-cho
Chiyodaku Tokyo 101-8457
JAPAN
Tel.: +81 3 5280 3429
Fax: +81 3 3429 3264
ibamoto@cck.dendai.ac.jp

Alt. Delegate

Xiaomei Li
Heat Pump & Thermal Storage Techn. Center of Japan
28-5, Nihonbashi
Kakigara-cho, 1 chome
Chuo-ku Tokyo
JAPAN
Tel.: +03 5643 2404
Fax: +03 5641 4501
li@hptcj.or.jp

Korea

Delegate

In-Hwan Oh
Energy and Environment Research Division
Korea Institute of Science and Technology
#39-1 Hawolgok-dong, Seongbuk-gu, Seoul,
REPUBLIC OF KOREA
Tel.: +82 2 958 5272
Fax: +82 2 958 5199
oih@kist.re.kr

Norway

Delegate

Kirsti Midttomme
Norges Geotekniske Institutt (NGI)
Postboks 1230 Pirsenteret
N-7462 Trondheim

NORWAY
Tel.: +47 22 02 19 90
Fax: +47 22 23 04 48
Kirsti.Midttomme@ngi.no

Sweden

Delegate

Conny Ryytty
The Energy Technology Department
Swedish Energy Agency
P.O.Box 310,
S-69104 Eskilstuna
SWEDEN
Tel.: +46 16 544 2096
Fax: +46 16 544 2261
conny.ryytty@energimyndigheten.se

Turkey

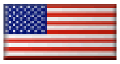
Delegate

Halime Paksoy
Çukurova University
Faculty of Arts and Sciences
Chemistry Department
TR-01330 Adana
TURKEY
Tel.: +90 322 338 6418
Fax: +90 322 338 6070
hopaksoy@cu.edu.tr

Alt. Delegate

Hunay Evliya
Çukurova University
Centre for Environmental Research
Chemistry Department
TR-01330 Adana
TURKEY
Tel.: +90 322 338 6361
Fax: +90 322 338 6361
hevliya@cu.edu.tr

USA



Delegate

Imre Gyuk
U.S Dept.of Energy
1000 Independence Ave
Washington DC 20585
USA
Tel.: +1 202 586 1482
Fax: +1 202 586 5860
Imre.Gyuk@ee.doe.gov

Alt. Delegate

Lynn Stiles
Richard Stockton College
NAMS PO Box 195, Pomona

NJ 08240-0195
USA
Tel.: +1 609 652 4299
Fax: +1 609 652 4972
lynn.stiles@stockton.edu

Sponsors:

IF Technology

Delegate

Aart Snijders
IF Technology b.v.
Frombergstraat 1
P.O. Box 605
NL-6800 EA Arnhem
The NETHERLANDS
Tel.: +31 26 3274965
Fax: +31 26 4460 153
a.snijders@ifinternational.com

Energesis Ingeniería, S.L.

Delegate

Luisa Cabeza Fabra
University of Lleida
Edifici CREA
C/ Pere de Cabrera s/n
25001 Lleida
SPAIN
Tel.: +34-973-00 3576
Fax: +34-973-00 3575
lcabeza@diei.udl.cat

Alt. Delegate

Raquel Sancho Moscardo
Energesis Ingeniería, S.L.
Paseo de las Facultades, 12.
Entresuelo derecha
46021 Valencia
SPAIN

Institute of Heat Engineering

Delegate

Roman W. Domanski
Warsaw University of Technology
Thermodynamics Division
Polish State Committee for Scientific Research
Ul. Nowowiejska 25
PL-00-665 Warsaw
POLAND
Tel.: +48 22 825 52 70
Fax: +48 22 825 05 65 or
+48 22 825 52 76
rdoma@itc.pw.edu.pl

Alt. Delegate

Maciej Jaworski
Warsaw University of Technology
Ul. Nowowiejska 25

PL-00-665 Warsaw
POLAND
Tel.: + 48 22660 52 09
mjawo@itc.pw.edu.pl

Secretary:

Andreas Hauer
Bavarian Center for Applied Energy Research, ZAE Bayern
Technology for Energy Systems and Renewable Energy
Walther-Meißner-Str. 6
D-85748 Garching
GERMANY
Tel.: +49 89 32 94 42 16
Fax: +49 89 32 94 42 23
hauer@muc.zae-bayern.de

Barrels of Sake in Tokyo

International Energy Agency
Energy Conservation through
Energy Storage Programme
ECES

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